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The Story of the Birds

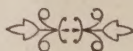
Founded on a series of Broadcast Addresses

delivered to the

❧ Schools in Sheffield. ❧

❧ Synopsis. ❧

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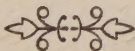


Corrigenda.

TO THE READER.

- PAGE *Errors marked with a dagger call for attention; the rest are trifling.*
- †31, FIG. 6, for Tarso. Metatarsus read Tarso-Metatarsus, for Carpo-Metacarpal read Carpo-Metacarpus, for R.—Rib read Rb.—Rib, for R. (arrow pointing to a rib) read R.B.
- †32, line 5, for r., read rb.,
- †36, line 13, for r. read rb. line 4 from bottom for r., read rb.,
- †50, line 5, for FIG. 16 read FIG. 14, line 6 from bottom, for carpo-metacarpal read carpo-metacarpus.
- †63, FIG. 14, add S.A.—Sacrum to the list of bones of skeleton.
- 93, line 10, for frame-work read framework.
- 98, line 10, for Blue-Tit read Blue Tit.
- †104, line 6 from bottom, omit where.
- 110, FIG. 24, for vary read varies (small print).
- †111, EXPLANATION OF PLATE VI, line 8, add M.—Feather of Emeu. Webbing, open network. Barbules visible. Aftershaft extremely long.
- †118, FIG. 26 read FIG. 25.
- 136, FIG. 27, line 2, for pull read pulls (small print).
- 145, line 13 (Synopsis), for extraordinary read extraordinarily.
- †162, line 7, for r. read rb.
- †185, line 7, for 38 read 37.
- 188, line 3 from bottom, for in-rushes, read inrushes.
- 192, FIG. 38, for Cones read Coues (small print).
- †196, FIG. 40, for B.—RIGHT HALF read B.—LEFT HALF, for H.—Tongue-bone read H'.—Tongue-bone, for T.—(in B.), read T'.—(in B.)
- 207, line 9 from bottom, for its read the.
- 211, line 7 from bottom, for gentle read gently.
- 246, FIG. 46, for HEAD-LONG read HEADLONG.
- †267, lines 4 and 20, for XVII read XVIII.
- 318, line 3 from bottom, for moor-land read moorland.
- 336, FIG. 63, for BIRD LIFE read BIRD-LIFE, for sand flats read sand-flats.
- 338, line 18, for Red-Throated Diver read Red-throated Diver.
- 341, line 1, for Black-Backed read Black-backed.
- 357, line 7 (Synopsis), for Passage migrants read Passage-migrants.
- 413, line 3, for renders read render.
- 443, PARAGRAPH HEADING, for RAFT read 'RAFT.'
- 444, FIG. 81, for RAFT read 'RAFT.'
- 457, line 9 from bottom, for offorded read afforded.
- †470, line 21, for 401 read 403.
- †471, line 14, for 36 read 37.
- †474, line 15, for 447 read 450.
- †475, line 29, for 381 read 379, line 30, for 346 read 348.

Observe, the last four errors occur in the Index.



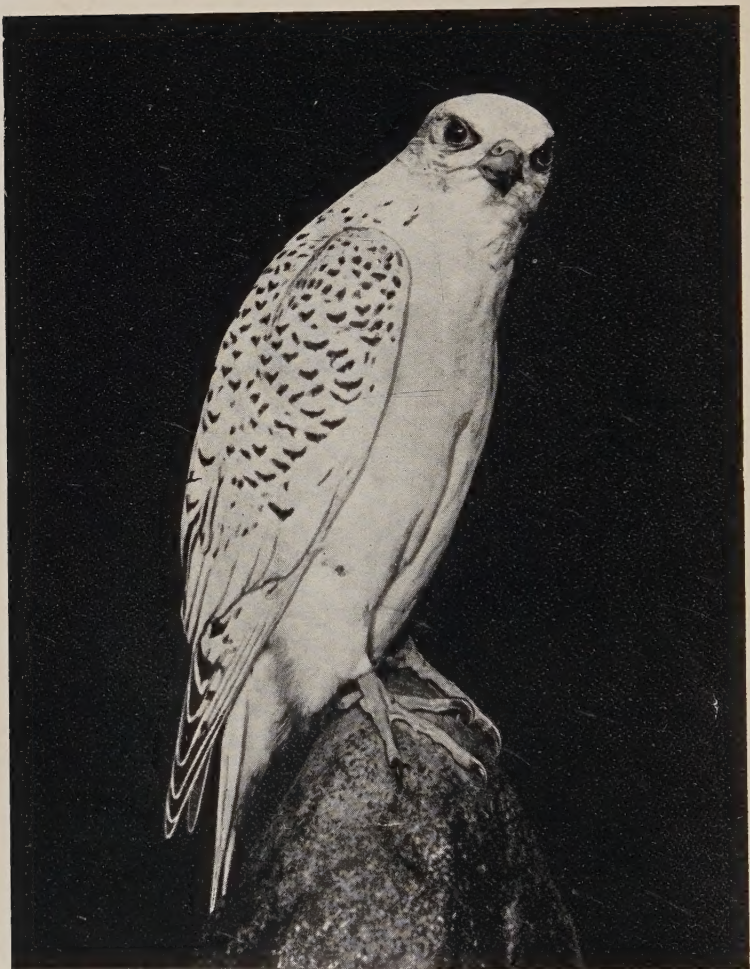




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❧ A Stately Visitor. ❧



(Photo of a specimen mounted by Messrs. Sheals)

❧ A Masterpiece of Taxidermy. ❧

GREENLAND FALCON.

"Arctic American visitors....travel to our shores by way of Greenland, and thence by the north-western groups of European Isles....Several species native to Greenland, such as the Greenland Falcon, the Greenland Wheatear, the White Wagtail, and others, when on migration, reach our coasts by this route."

The Story of the Birds

A Guide to the Study of Avian Structure and Habits

FOUNDED ON A SERIES OF BROADCAST ADDRESSES DELIVERED TO THE
SCHOOLS IN SHEFFIELD.

BY

CHARLES J. PATTEN, M.A., M.D., Sc.D.

PROFESSOR OF ANATOMY, SHEFFIELD UNIVERSITY.

Author of

"The Aquatic Birds of Great Britain and Ireland," etc., etc.



PROFUSELY ILLUSTRATED WITH
LINE-DRAWINGS, SKETCHES, PHOTOGRAPHS,
AND MAPS.

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CLASS;

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TO
THE MEMORY
OF
MY BELOVED MOTHER
THIS BOOK
IS
AFFECTIONATELY DEDICATED.



THE HOVERING HUMMING-BIRD.

❧ Preface. ❧

I CANNOT say that, on the completion of my first series of wireless addresses,—nineteen in number,— to schools, I had formed any very definite idea of publishing them. At most, I had a hazy notion that some might perhaps find their way into newspapers or other journals. Encouraged however, by many appreciative letters from listeners, I started, yet with some feeling of diffidence, to weave my manuscript into book-form, but without expanding it. In other words I originally intended to publish my essays *verbatim*. In this form the material available would have yielded a slim brochure of less than two hundred pages. However, I grew intensely interested in the subject, with the result that a substantial volume, illustrated with line-drawings, sketches, plates, and maps, is now presented for publication. At the same time I am bound to admit that my broadcast addresses to schools laid the foundation of my ultimate project. It is to these addresses I owe whatever inspiration I have been capable of putting into the work, and I look back with great pleasure to their preparation and delivery, and to the very courteous appreciation of my efforts, shewn by Major T. H. Howard, Director of the Sheffield Wireless Station.

While my ambition has been to prepare a volume which may find a place in educational circles, a volume which may serve as a guide, not only to the study of the habits but also

of the structure of birds, it will become evident to the reader that a complete survey is not here attempted. The general concepts of the nervous system, and of the development of the chick within the egg, were omitted, among others, from my series of wireless talks. The study of the brain and mentality was excluded, whereas that of the feathers, bones, joints, muscles, and most of the viscera,—all easily examined without special technique,—received prominence. However, there are many good works on avian structure with which the student can supplement his investigations.

The book, it is gratifying to say, has been profusely illustrated with *original* text-figures. No pretence has been made to represent these as other than simple line-drawings and sketches. But there is an interesting point to make. Many of the pictures have been created, not copied, or even adapted. They have been built up from my verbal descriptions—from pictures vividly impressed upon my mind scores of times, pictures painted on Nature's 'canvas.' Vividly, indeed, I can see the advent of the Peregrine Falcon at the sand-flats. To me the impression of this picture is always that of a bomb bursting among multitudes of shore-birds, so 'explosive' becomes their flight in an instant. Sandpipers shoot vertically like rockets to the clouds; ducks drop like meteors to the water; screaming lapwings twist and swirl 'twixt sky and sea. Vividly I can see myself surrounded by hosts of sandpipers, delightful little sprites, racing about hither and thither. But there is no need to offer further annotation of the sketches and line-drawings. Suffice it to say I feel confident that any ornithologist, in looking through this book, will agree that these illustrations, to which may be added "The Owl's Siesta"; "The Hovering Kestrel"; "Albatross Wheeling"; "The Back-to-front Owl at the

Zoo"; "Winter's Picture of Marine Bird-life"; "At the Farmyard Gate"; and many others; are true to Nature.

In addition to carrying out practical work, we must have pictures in plenty to understand anatomy. Indeed, anatomical study is largely a pictorial study. Therefore I have considered it most desirable that the chapters dealing with structure should be copiously illustrated.

It is not in my power to express adequately the sincere and grateful thanks which I owe to Miss J. M. Ferguson, B.Sc., and Dr. W. J. Vincent, for the numerous sketches which they have contributed; sketches which form, in a long way, the main bulk of the total number of illustrations.

In proceeding with the editing of the manuscript I grew more and more deeply interested, with the result that this volume has far exceeded the bounds of my original expectations. But I never could have completed my task in such a manner as to render the elucidation of the text adequate, had not my two artist friends stood by closely all the time. This they did with unstinting generosity, for which indeed I feel imbued with a very deep sense of gratitude. The vivid sketch entitled "The Blackcaps' Duel" has, in a large measure, been adapted from H. Grönvold's delightful drawing which appears in Mr. H. Eliot Howard's monumental work on the "British Warblers." It is a pleasure to have had cordial co-operation in this direction, which I gladly acknowledge. The small text-figure, entitled "The Merlin's Headlong Plunge," appears in "Birds Useful and Harmful," by Herman and Owen, and I am greatly obliged to Messrs. Sherratt and Hughes, Publishers, for consenting to its reproduction.

Through the kind courtesy of Messrs. Macmillan & Co. Ltd., I have been granted permission to reproduce three of Tenniel's unique illustrations from that immortal classic, "Alice in

Wonderland." The reader, no doubt, will agree with me that it is a matter of subtle interest to find these pictures adapting themselves to what I have to say regarding the framework of the bird's body and the woolly coat of early life!

I have made myself largely responsible for the selection and preparation of material for the plates. Several of the photographs of birds have been taken from life: others,—notably those in which the back-ground is dark,—have been taken from specimens which I have collected and mounted. Anatomical studies are represented by photographs of dissections which I have specially prepared.

I am pleased to have the opportunity of including two photographs—one of two Redshanks and a Greenshank, the other of a group of Turnstones,—taken by Mr. H. Brooke, formerly Assistant in the Pathology Department at the South Yorkshire Mental Hospital. These pictures are selected from a large and excellent series, made to illustrate the plates in my "Aquatic Birds." The illustration of the Turnstones appears for the first time, an alternative having been used for the above-mentioned book.

I am also much indebted to Mr. Fordie—artist in the firm of Messrs. Pawson & Brailsford—for his excellent drawing of the horse's skeleton, reproduced as a plate, also for his careful tracings of Gannets and Rooks, made from photographs of specimens which I specially prepared. These pictures illustrate curious features relative to the disposition of the skin which clothes the upper regions of the hind-limbs. The same artist also bestowed much care in the preparation of the maps.

The plate of the Birds-of-Paradise and Humming-Birds is reproduced from my original photographs of mounted bird-groups in the Zoological Museum in our University. I take

the opportunity of thanking Professor H. Graham Cannon for placing the specimens at my disposal, also for his drawings, illustrating the body-cavity and its contents. The striking plate of *Archæopteryx* (a curious ancestor of the bird); two others, depicting birds in flight; a fourth, giving the distribution of the air-sacks; and a fifth, shewing Robins fighting; are reproduced from sketches made by Dr. W. J. Vincent.

Messrs. Sheals of Belfast, generously presented me with the photograph of the Greenland Falcon, from which the plate has been prepared. The picture is most arresting; the subject is so life-like that, in my opinion, it is a masterpiece of taxidermy. I say unhesitatingly that these brother taxidermists cannot be surpassed in their skill in setting up and imitating life. I greatly appreciate their valuable contribution.

A word in regard to the arrangements of the illustrations. It will be seen that, in a large measure, I have adopted a system of grouping the subjects. I trust this will serve a useful purpose. It certainly should, where structures require linking together for their better elucidation, for instance the bones of the limbs, more particularly in their connections with the bones of the trunk. Birds, related to one another; for example, Meadow-Pipit and Tree-Pipit; Sedge-Warbler and Aquatic Warbler; Siberian Skylark and Common Skylark; are also grouped, so that two birds in each case make one text-figure. Such an arrangement I hope will lend itself to ready reference.

It may be noted that short quotations from the text have been introduced under the illustrations. There is nothing really novel in this procedure. It is commonly adopted in works on fiction, and, for my own part, it seems to refresh one's memory of the text. However, in a work on ornithology it may be looked upon as a new departure: I trust it will suit the taste of my readers.

I must not let the opportunity pass by without acknowledging the work my son has accomplished in compiling the Index.

There still remains a duty to discharge—a very pleasant one—namely, to tender my very sincere thanks to the Staff of Messrs. Pawson & Brailsford Ltd., for the unremitting attention given while the sheets were passing through the press.

I should like also to mention that the personal interest which the Publishers have taken in the manuscript from the beginning, has been most helpful. It is gratifying to feel that numerous suggestions—in many cases amounting to innovations—have been carefully considered and adopted, thereby allowing considerable scope for originality.

C. J. PATTEN.

University, Sheffield.



❧ Introduction. ❧

IT may be well to introduce to the reader the scheme adopted in the building up of this volume. In my experience, the youthful ornithologist, bent on serious study, invariably expresses a desire to handle the bird, in addition to watching it in its natural haunts. With perspicacity he sees the futility of trying to study plumages and other features adequately, by mere observation on the living bird, even at close quarters. It is more futile still in the case of shy, wary, species, even when viewed through powerful and brilliant light-transmitting binoculars. Size, weight, body-temperature, eye-colour, and other points, cannot be determined properly without handling the living and the dead bird. The latter, however, is easier to obtain, and on it many of these features (omitting body-temperature) can be investigated with facility. Furthermore, one comes across a great number and variety of dead specimens. This is a very fortunate state of affairs, for no doubt our zealous student would wish to compare not one, but a score or two of different forms of beaks, feet, eyes, wings, tails, and so on. He would discover that variations in the feathers formed a wide subject, demanding plenty of material to work upon.

The opening remarks in the second chapter run: "I picked up a beautiful Herring-Gull in a perfectly fresh condition, only dead about ten minutes." What is the inference? That anyone might do likewise when searching for dead birds. Here is a point of importance, as we shall see in a moment.

Sea-birds are subjected to manifold vicissitudes, and their beached bodies, fresh and in excellent condition, are of common occurrence. The bird-student residing near the coast, is often given the chance of picking up gulls or guillemots—especially after rough weather,—which being conveniently large and tough, make good specimens for anatomical investigation. Apart however from a chance find, anatomical material may be obtained from many other quarters. Firstly, from the poulterer. Fowls, ducks, and pigeons, at all times: various game-birds and rooks, at certain seasons. The latter possess interesting characters and are inexpensive. From game-keepers, farmers, and fruit-growers, quite a large number of species may be obtained. Hawks, owls, crows, magpies, jays, blackbirds, thrushes, and starlings, are birds of the higher classes, and they furnish instructive material. The depredations caused by these species in some districts require to be kept in check; hence victims slain can be pressed into the services of the investigator. Thousands of birds sacrifice their lives through striking lighthouses, and, by getting into touch with light-keepers, valuable material becomes available. Splendid specimens, some unusually large in size, may be obtained from zoological gardens, although in more limited numbers.

Obviously, when available sources are tapped, a plentiful supply of material can be procured *without the student taking life for the special purpose of anatomical investigation*. Yet we hear of certain individuals subscribing to the strange notion that unquestionably, the student should not be encouraged to procure and dissect dead birds. Such a procedure is hardly edifying, and is at variance with those tender and æsthetic feelings which permeate the minds of those who delight in watching the living bird in its natural haunts. I am unable

to join issue with this line of argument. Habit cannot be studied in proper perspective apart from structure, and surely the investigator should be encouraged to acquire that fascinating knowledge which the skilled use of the scalpel can reveal !

The observer who pays attention only to field-work will remain an amateur all his life. True, hundreds of persons derive great pleasure in watching the habits of birds, but for those who desire to lay the foundation of deeper knowledge and a wider outlook, the dead bird must be overhauled from *top to toe*. Following along these lines, the reader will see why the two opening chapters deal with the living bird in the hand and the dead bird on the table.

It has been urged that the study of structure involves technicalities, dry and tedious for the beginner. By the judicious use of simple language, of similes, of anecdotes and reminiscences, and what is most important, of a liberal series of useful illustrations, clear and not overloaded with details, the dry and tedious technicalities may be reduced to a minimum—nay more, they actually may become supplanted by an arresting study which tends to stimulate thought, and to widen our sense of beauty to such an extent that we see in the lifeless, yet marvellous piece of architecture lying on the table, nothing but surprise at every turn.

In the next three chapters we plunge into the study of anatomy, and gain some conception of the bony framework of the trunk and limbs. We learn, among other things, that the skeleton forms the scaffolding of the body ; that it is the handmaid of the muscles ; and, in a large measure, serves as an encasement for the vital organs.

In the following chapter, which treats of the hind-limb in action, our view-point becomes general rather than technical, and our task, now rendered very easy, deals in the main with

remarkably interesting correlations between structure and habit. In an analysis of various types of feet this is notably the case. In some species feet virtually become hands ; toes, in a large measure, function as fingers. • In other species toes remain toes which cannot clasp. The fore-limb in action, in other words, the mechanism of flight, is dealt with in a later chapter, when the feathers have been carefully studied.

Every little child loves a soft, woolly toy—a teddy bear or fluffy chick. Our *little ones* become delighted when we take them for a ramble, and in a picturesque wood meet three quaint little visitors, each wearing a soft, woolly, coat. In fairy-narrative we trace the history of baby-plumages, and learn how beautifully the dresses of our little visitors are adapted to their particular wants. Having given the young folk an *intellectual treat* in the open air, we hasten back to the room and examine the architecture of the feathers in our Herring-Gull.

The next chapter sees us wending our way to the museum with our Herring-Gull, skinned, mounted, and ready to present to the Curator, who graciously accepts the gift. Several delightful hours are spent in studying a variety of costumes—juvenile, winter, and marriage-garbs, most wonderful liveries with ornamental appendages,—surely a liberal wardrobe !

An important milestone now marks the course of events. We attempt a little practical anatomy. Having completed our investigations of the feathers and skin of our Herring-Gull we turn our attention to the limb-muscles, some of which we isolate, steadily pull, and then watch their actions. We grow familiar with the muscles which spread and fold the wings, bend the knees, open and close the toes, and so on, with other actions. We make ready to appreciate the general principles of muscular mechanism, notably the manner in which the wing-

strokes are effected. But we find it only possible to touch the fringe of this difficult problem, and we endeavour to lighten the load of our work by similes, anecdotes, and analogies.

We dose off to sleep in our comfortable arm-chair ; our muscles relax ; the book falls to the floor ; soon the tobacco-pipe follows suit ! Yet the bird in its slumbers clasps the perch tightly all through the night. We engage attentively in the study of this fascinating piece of mechanism.

Step by step we proceed on a deeper plane with our dissections. Already we find ourselves exploring the body-cavity and examining its wonderful factories and engines. Five chapters are devoted to this part of the subject. The close correlation between the form and position of the heavy organs and the balance of the body during flight ; the extensive system of air-sacks, rendering the bird highly pneumatic ; and the vocal apparatus, unique in structure and mechanism ; stand out as features of special interest.

Our dissections quite completed, the dead bird no longer lies on the table. Being now in a position to appreciate voice-production, we yearn to try and interpret bird-language. So, after studious indoor work, we repair to beautiful woods and glades where we enjoy a long day in early summer, listening to sweet and varied melody.

At this juncture let me emphatically say that in my experience I have found it difficult, if not at times futile, to teach young people—and indeed adults also—bird-language, without affecting the dramatic touch. At times I seem to pose as a drill-sergeant ! The pupil, I insist, must be prepared to obey orders instantly, and at the same time to take up the cue with full enthusiasm.

On a sudden, at the word of command, he must be ready to halt and listen attentively *over and over again* to what the

bird has to say. At the word of command, he must crouch and remain silent ; just as suddenly he must strain his neck to peep over a wall or other fence ! He must learn quickly to distinguish between call-notes, battle-cries, and the song. He must learn quickly to pick out the particular notes of one bird from amidst a chorus of surrounding vocalists. All this requires assiduous practice on the part of the pupil, and constant repetition and unflagging zeal on the part of the instructor. If therefore my diction in the chapter on "*The Language of Birds*" may strike the reader as being somewhat over exclamatory, I would ask him to bear with me, seeing that I write in that strain for a set purpose. When training young people to become acquainted with bird-language, I behave somewhat after the fashion of a chorus-master who insists on rehearsing his choir *over and over again*, until the members grow perfectly familiar with their parts !

With the help of our anatomical knowledge we are able at this stage to appreciate the broad principles of *flight-mechanism*. Then we have a very delightful day's outing, o'er beach, marsh, and hill-side, to watch the living birds on the wing. Fortune favours us, many species, including long-winged, short-winged, powerful and feeble fliers, coming under observation. We learn that velocity in flight is remarkable in some species, yet it remains a feature of secondary importance when compared with endurance.

Naturally enough our thoughts now turn to the subject of migration, in which long journeys demand endurance on the wing. Several chapters, taking us to the end of the book, are allotted to this engrossing, yet comprehensive theme. We ask, at the outset, why birds migrate, seeing the grave dangers which beset their travels : next we look into the question of geographical distribution ; we note the weather influences,

and how 'Jack Frost' befriends the ornithologist; we repair to an estuarine coast in mid-winter to study marine bird-life with its wonderful revelations; after a most enjoyable ramble we return home and remain indoors until we have carefully drawn up a classification of migrants, and have considered the movements of birds, native to the Southern Hemisphere, and the normal fly-lines and distribution of American migrants.

A chapter giving an account of those sudden spasmodic 'invasions' of certain species, at irregular intervals, followed by problems regarding purely casual visitors, forms a befitting introduction to bird-observations at lighthouses, whence the highest percentages of rare casual visitors have been recorded. Birds new to Ireland, collected during my residence at Irish light-stations are described briefly and figured.

The concluding chapters treat of problems concerning Trans-Atlantic migrations. Here, a timely note of warning is struck, seeing that the evidence of unassisted journeys across the Atlantic requires most careful sifting. With the view of instilling that point into the youthful mind, a yarn is spun round a kernel of truth, the moral being allowed to speak for itself.

Having followed the manner in which the chapters in this volume have been woven together, gladly may I add that most of the field-studies denote actual incidents which I can look back upon with no small degree of pleasure.

It was during a delightful ramble along the Yorkshire coast that I actually picked up the Herring-Gull, mentioned in an opening paragraph of the second chapter,—a bird which plays a leading part in the pages of the book. Moreover, this Gull was in such an interesting phase of transitional plumage, that I was led to present it to the Sheffield Museum. In the

chapter entitled, "*Birds and their Costumes*," I find myself, with a party of children and a stuffed Herring-Gull, paying a visit to a museum, where a happy day is spent in the study of plumages. Is it not easy to see whence the inspiration came which furnished the subject-matter?

Then again, I am vividly reminded of the first time that I detected a Bramble-Finch among a party of Chaffinches, on a hard frosty morning in my small suburban garden. Joy o'ertook me when I beheld Redwings under the same circumstances. By scattering plenty of food I encouraged these most welcome visitors to keep near the door-step. Here, then, is the foundation of the chapter, "*Jack Frost sends another Visitor*." The description of the visit to an estuarine coast on a mild, genial, calm, bright, day in December, which is given in the chapter "*Marine Bird-life in Winter*," brings back happy memories of week-end rambles over the extensive sand-flats and slob-lands of Dublin Bay, teeming with bird-life. I see before me the Brent Geese floating on waters tranquil as a sheet of glass and within a few paces of passing tram-cars. I see a perfectly natural bird-sanctuary whose inmates wisely keep close to the highway traffic where the gunner dare not molest them: inmates much sought after by the fowler, yet inmates as safe here as if they were pinioned on an ornamental pond in a city-park. Such are but a few selected of the field-studies which serve to build up some of the chapters of the present volume,—field-studies founded on direct personal observation. There are several others which the reader will discover for himself.

It will be seen that I have put in a word in favour of protecting our feathered friends. Birds are, on the whole, beneficial to Man. It is only when certain species get out of hand and become decidedly depredatory to crops and fruit

that their numbers may require thinning out. Birds-of-prey lay claim to far more consideration than is usually meted out to them. Like other predatory animals, they are, of a truth, '*the salt of the earth.*' Their wholesale destruction by game-keepers and farmers has more than once recoiled upon the heads of the destroyers. The Barn-Owl is a nocturnal rat-trap; the Kestrel, a diurnal mouse-trap. Neither of these birds should ever be shot. I trust that the delightful full-page sketch, entitled "*The Hovering Kestrel*" will make a strong appeal: it certainly should do so, seeing that the destructive miniature rodents, upon which this charming little falcon largely feeds, are allocated a prominent 'front-seat' in the picture!

Lastly, it should be carefully borne in mind that this book has been written essentially for, and addressed to, young people. For that reason I have endeavoured, to the best of my ability, to arrest the reader's attention and stimulate thought, by imparting a considerable amount of light and shade to my exposition. Intensive indoor studies, carried out in a very sober, serious mood, alternate with field-expeditions so delightfully exhilarating, that the high lights in the text become, in no small measure, vivid and at times exclamatory; while all along the line an informal, chatty, and personal touch, has been maintained. How far my attempts in this direction may fulfil the purpose, it is for others to say.



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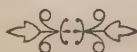
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'Melody in Battle' was presented after arrangements were completed for press. Its appropriate position is between PLATES xvi and xvii. In order not to disturb the sequence, and also numerous references in the text, this plate has been accorded the number xvi [A], on the List.





THE WHEELING ALBATROSS.

The Story of the Birds.

LECTURE 1.

CHAPTER I.

A LIVING BIRD IN THE HAND.

The heroine of 'Wonderland'—Imagination, a highly treasured gift—Observation—Nature-Study—Immense value of early training—"Let's pretend"—We all assemble—The room with a thousand windows—A bird in our hand—First question—Distinguishing characters of birds—Body-temperature of birds and mammals—What is a mammal?—Curious forms—Bat, whale, porpoise—The heart's trill—Sudden terror—A cat passes the window—The bird's amazing sight—Powers of expression—The eyes the 'windows of the soul'—Body-weight—Thirty-two goldcrests by post for a penny—All birds heavier than air—The captives set free—The great feast of the corn—Amazingly hearty appetites—Destruction of insect-pests—Benefactors of Man—Wisdom of protecting our feathered friends.

MANY of you, my dear young friends, have heard of a sweet, engaging, little girl named Alice, who was so kind and polite to those strange creatures which she met during her thrilling adventures in 'Wonderland.' Alice possessed a highly treasured gift; you also possess it, and I am anxious that you should learn to use it in the right way. I mean,—the gift of *Imagination*. True, in Nature-Study, we must first observe for ourselves the various animals,

plants, and so forth, which we wish to study ; moreover we must handle and dissect them whenever the chance arises. By so doing we grow familiar not only with their names and the localities in which they are found, but also with their structure and other features ; all most important in their own way. But you will never become zealous lovers of Nature until you develop a desire to ask yourselves a great many more questions, and, through your own imaginative powers, try to discover some way or another of approaching the answers. It is far better when you see a bird in the air, to say it flies because it has wings, than to pass by without noticing its movements. Later on, you will learn that the wings are only partly instrumental in enabling a bird to fly. It is far better for you to say that a bird sings because he wants you to hear his sweet voice, than to take no notice of his vocal powers. Later on, you will take a lively interest in the song when you learn that there are a great number of reasons why he should sing : you will be filled with curiosity to find out why the little minstrel should pour forth his tuneful melody when angry, indeed when sometimes furiously engaged in a 'hand to hand' battle.

When you see your pigeons gobbling up the grains of corn as fast as ever they can (until their crops become distended and gorged to the utmost extent), it is far better to say, " I am really ashamed of my pets for being so greedy," than merely to scatter the corn and take no notice of their 'table-manners.' Later on, when you study very carefully the marvellous machinery of their body, you will learn why it has become absolutely necessary, not only for your pigeons, but also for all birds to have immensely hearty appetites, without being in any sense greedy.

Many of you have read not only of Alice's adventures in 'Wonderland,' and how, when just dropping off to sleep

she imagined that she reached the magic land after travelling down a rabbit's burrow, but also how, after conjuring up in her mind another imaginative picture, she again dreamed of a land of magic, reached this time by passing through the looking-glass over the mantelpiece. Her thrilling adventures, even in the distorted picture of Dreamland, indicated a powerfully imaginative child-mind.

“LET'S PRETEND.”

Indeed, before she disappeared mysteriously through the looking-glass, you recollect that she had repeatedly addressed her black kitten by saying: “let's pretend” so and so. Now I am also going to stretch my imagination to a very considerable degree. “Let's pretend” that you all can see me; that I have come to talk to you in person; and that I can hear your answers to questions which I propose to ask. Furthermore, “let's pretend” that no matter how many of you give the same answer, I shall be able, like a magician, to hear it as one voice. Then all the answers which I expect to receive at the outset, in regard to the distinguishing characters of birds, will not be long rolling in.

THE ROOM WITH A THOUSAND WINDOWS.

“Let's pretend” that each one of you is holding a little bird in your hand, and that we are in a gigantic room enclosed on all sides by windows. Now, juniors, let me have your answer first! Yes; “a bird is surely a fluffy little creature covered with feathers and it can fly”; remember however, there are actually some birds which cannot fly—later we shall have more to say about them. What made you think of saying “fluffy”? Was it because you saw a chaffinch in your garden this morning fluffing out its feathers while it

combed them with its beak? Very good: we shall see the importance of that observation in a chapter further on. Next, will the seniors give their answer. "A dear little creature which can fly, sing, build a neat nest, and lay lovely little eggs, some sky-blue, some white, some all spotted." So far correct,—we shall have many interesting things to say about the song, and about nest-building and colouration of the eggs, another time. Anything else? "Your birds feel very warm."

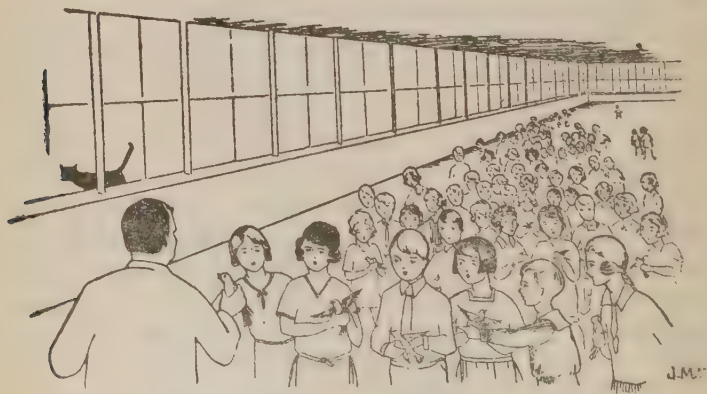


FIG. 1.—THE ROOM WITH A THOUSAND WINDOWS

"But why should all the birds be so frightened? Surely those at the far end of this astonishingly large room could not possibly have seen the cat?"

Good indeed: a mouse, a guinea-pig, or any other mammal, would not impart such a feeling of warmth to one's hand. Wonderful to relate, a bird is warmer in its normal healthy condition than a mouse or a man is in a raging fever. In a state of health our body-temperature, and that of mammals in general, is just a little above 98° Fahrenheit, whereas in many birds it reaches 110° F. What is the significance of these

interesting facts ? It is, that the bird's blood is hotter and flows faster than that of mammals. It must follow then that the pumping, or what is generally known as the 'beat' of the bird's heart is very fast.

WHAT IS A MAMMAL. ?

We had better make sure at this early stage of our studies that we understand what we mean by a mammal. Doubtless, most of you are already familiar with the term, but for those who are not, let it be remembered that it is hardly sufficient to say that a mammal is a four-footed animal which cannot fly. The crocodile and the lizard are four-footed and they cannot fly, but we know that they are reptiles, not mammals. The blood of reptiles varies in temperature and in cold weather is markedly chilled. On the other hand the temperature of the bird and mammal is *constant* whether the day be hot or cold. Again, some mammals *can* fly, for instance the bats, while others have only two limbs, for instance the whales, dolphins, and porpoises. A mammal then may conveniently be defined as an animal which is warm-blooded and (with exceedingly few exceptions which need not here concern us) always provides milk from its own body for its young ones.

THE CAT AT THE WINDOW.

Now what can be the matter ? You tell me that each of your bird's hearts has suddenly commenced to beat so rapidly as to impart a feeling to your hands almost resembling a trill ? Do you not see the reason ? I feel quite certain that some of you must have espied the cat passing that window close to where I am standing. But why should all the birds be so frightened ? Surely those at the far end of this astonishingly large room could not possibly have seen the cat ? Ah, yes ; every one

of our little feathered friends, even in the very short glimpse they obtained, recognised their dreaded enemy instantly. (Fig. 1.)

THE SIGHT OF BIRDS.

Birds have amazingly good vision. They can see objects at a distance with wonderful distinctness. A green-fly—you know that tiny insect a few millimetres in length, the pernicious pest of the rose-tree,—appears to a titmouse, at twenty yards distance, several times larger than it appears to us! That familiar little falcon, we call the Kestrel, can see a mouse or a grasshopper amidst entangled grasses or weeds, when far up in the air the little bird-of-prey appears to us as small as a sparrow! Take a good look at your birds: do they appear at all frightened? Have they the scared expression which they evinced when the cat glided past the window? Not a bit of it. We can read in their countenances that fear has already left their minds. We distinctly noticed that they looked quite terrified when the cat appeared. Well now, that being so, let me point out something which you could hardly have found out as yet for yourselves, with regard to the wonderful power a bird has of expressing the state of its mind. See! there is no play of expression discernible about its mouth; it has no soft movable lips which it can separate and raise when laughing, or close tightly when annoyed. It cannot purse, pout, or draw down the corners of its mouth when out of sorts; it has no eyebrows to raise, or furrows in the skin of the forehead with which to produce the expression of wonder; nor can rapt attention stimulate its brows to knit into a frown. The bird has no visible, projecting external ears which it can lower and pull back, whereby the expression of anger (so plainly seen in the cat when in a savage mood) is portrayed; or erect and carry forwards

Triumphs in Bird-Life.

Amazing Vision.



LITTLE OWL.

"Lustrous, sparkling eyes....highly expressive of varying emotions."

Hearty Appetites



KESTREL.

Birds play a very important part in the economy of Nature.

"Flycatchers capture for their chicks between two and three thousand flies in a week."



SPOTTED FLYCATCHER

Birds, taken as a whole, undoubtedly are great benefactors to Man.

"Destroyers of vast multitudes of terrible insect-pests, surely deserve our protection."

Astonishing Endurance on the Wing.



GOLDCRESTS.



CHIFFCHAFF.

(Photos by the Author).

"We cannot but marvel at these little feathered voyagers, as they forge ahead with undiminished vigour, more especially during the hours of inky darkness."

to signify suspicion of danger, so evident in the listening rabbit. And yet such mental states as fear, love, joy, sorrow, anger, and others, can be plainly read in those lustrous, sparkling eyes : —eyes so highly expressive of varying emotions that they may indeed be called the '*windows of the soul!*' Later on, we shall have interesting points to study regarding the eyes, in connection with intelligence, family-life, migration, and other features pertaining to bird-life. (PL. I.)

BODY-WEIGHT.

Have your hands grown tired ? Not in the least, and the reason is obvious. A little bird is so very light that one hardly feels conscious at all of its weight : each of these little feathered friends, which we hold, weighs less than a third of an ounce. The Goldcrest, the smallest of our British birds, weighs only about a dram, in other words about one-eighth of an ounce.

In the days before the Great War, when one could send a packet weighing four ounces *per post* for the sum of one penny, we see that (apart from the weight of the wrapper), thirty-two of these diminutive creatures could be despatched for that modest sum of money. Furthermore, the smallest Humming-Bird weighs only twenty grains or one-third the weight of the Goldcrest, therefore in calculating on the same basis, one penny would defray the postage of ninety-six of these fairy species.

Perhaps you may be inclined to think that the light weight of a bird is primarily to enable it to keep in the air when flying : this fact is only partly true ; later on, we shall learn that weight is really a very necessary factor in connection with the mechanics of flight. (PL. I.)

THE CAPTIVES SET FREE.

Doubtless, we have already observed several interesting facts regarding our living bird when held in the hand.

Should we open the windows and set the little captives free? I should think it were high time to do so, even if we have not finished all our investigations on the living bird. Do you agree with me, and if so I should very much like to know your reason? Let me throw out a hint by reminding you of the birds' immense appetites. The prisoners have been deprived of food and water for an hour, hence they must be very hungry. Not only your tame pigeons but also these small wild birds require plenty of food at very frequent intervals of time.

Away, away, happy little birds; liberty regained.

THE FEAST OF THE CORN.

But they have not flown nearly so far as we might at first have expected; our little friends have already forgotten the throes of their imprisonment. Look! they have alighted on those corn-stooks, scarce thirty yards distant, and immediately have become engaged in attacking the farmers' crops. (Fig. 2.)

When coal burns very swiftly, giving forth a brilliant, glowing heat, we all know that it is necessary to stoke up the fire repeatedly. The living body of the bird may be compared to a swiftly-burning, glowing fire; the large and oft-repeated consumption of food to the stoking of the fuel or coal.

IMMENSE APPETITES.

It is truly wonderful what an amount of food a bird can consume in the day. I have observed, among many of our familiar species, that the young when in the nest are fed on an average every three minutes. It is easy at times to establish

these calculations where food is abundant and the parent-birds flit to and from the same spot. A slice of bread or a good-sized boiled potato will very soon disappear if a pair of sparrows, rearing a young family, come on the scene and are allowed to set to work without interruption. Flycatchers capture for their chicks between two and three thousand flies



FIG. 2.—THE FEAST OF THE CORN.

"Away, away, happy little birds; liberty regained... Look! they have alighted on those corn-stooks, scarce thirty yards distant, and immediately have become engaged in attacking the farmer's crops."

in a week. (PL. I.) Wagtails, pipits, warblers, tits, and many other species, likewise levy a heavy toll on insect-life. The food which some small birds can consume seems almost beyond belief. It may amount to one-sixth of their own weight. Nestlings have still a more stupendous appetite. They can actually put away food in twenty-four hours equal to their own weight. It has been calculated that a young robin is able to dispose of fourteen feet of worm in twelve hours.

BIRDS BENEFIT MAN.

Here I must mention a point of vital interest which we should always try to keep uppermost in our thoughts. It is this: birds which live entirely upon insects are our best friends, and indeed many others, which, in addition to eating insects, add to their *menu* worms, seeds, and berries, also come to our aid. Such wonderfully efficient destroyers of vast multitudes of terrible insect-pests, surely deserve our protection, especially in localities where danger seriously threatens to thin out their numbers. It is true that they actually help us to keep up our food-supplies, more particularly in the case of our home-grown crops. We are aware, of course, that birds will treat themselves to our crops of corn, fruit, and other edible vegetable products. Nevertheless, taken as a whole, our feathered companions are beneficial to Man. Blackbirds, thrushes, and starlings, are very fond of fruit, indeed they have a pronounced greed for such tit-bits: sparrows, chaffinches, greenfinches, and others of their sort, evince a great love for grain. All however do beneficial work by destroying insect-pests when harvest-times are past. Hence we require to exercise careful judgment, and we should not think of thinning out the bird-population in any district unless it happened to show an uncontrollable increase. Even then a proper balance should be maintained. (PL. I.)

CHAPTER II.

A DEAD BIRD ON THE TABLE.

A dead Herring-Gull picked up—Immediate examination—Signs of its fresh condition—The eye-test—Telescopic features and colours of the eyes of various birds—A hunt for the ears—Their form and characters—Hearing—Calling a piping redshank—Accuracy in locating sounds—The nose and how to find it—The nostrils of the Petrels—Sense of smell—Experiments—Vulture—The Curlew and gun-powder—The beak—Its various forms and functions—Gizzard as 'back-teeth'—Flexibility and other characters of the neck—The 'back-to-front' owl at the Zoo.

I HAVE been quite fortunate this morning. During my ramble along the sea-beach I picked up a beautiful Herring-Gull in a perfectly fresh condition, only dead about ten minutes. "Let's pretend" that I am shewing it to you a couple of hours later in the day. I shall place it on the table, breast uppermost in the first instance, for the purpose of immediate examination. How do I know that the bird had only just died when I first found it? Because it was as yet warm, and quite limp. Now, however, in a couple of hours it has grown cold and very rigid. Will this rigidity or stiffness pass off? Yes; to-morrow the body will be limp again, and of course quite cold. A bird remains stiff only for four to six or seven hours after death according to weather and other circumstances.

THE EYE-TEST.

When the stiffness has passed off, what test can be readily applied to prove that the bird had died not many hours previously ? The eye-test. Obviously then, we must proceed without delay to examine the eye, a wondrous organ in the bird. At the last ebb, just before the machinery of life stopped working ; before the little furnace had been quenched, the under-lid became relaxed and spread itself up over the eye like a curtain. Gently expose the eye-ball by lowering this lid with the tip of your finger and you will see at once that the transparent glass-like front part, we call the *cornea*, has commenced already to shrink and show streaks, like cracks on glass or frills on a gelatine film. In a short time this glassy window will have collapsed to such an extent that its curvature, which is convex outwards in life, will have become concave, so as to abut against the *iris* or coloured part of the eyeball. We may compare this condition of the eye to a hollow rubber-ball with a dent in it. What can we learn from this observation ? That in life this curiously brilliant front-window is movable and can pass forward and backward like a tube of a telescope. Such an arrangement allows the bird additional power of rapidly changing its focus when viewing objects. In swift flight the telescopic action comes beautifully into play ; as a result, far and near objects can be kept clearly in view. When the bird dies, the ' telescope ' commences to shorten, and in about eight hours' time has, so to speak, completely closed up in its case. Nay more ; it has actually become inverted and collapsed. But we have seen that the glassy window of our Herring-Gull had not yet collapsed. Our specimen therefore has not been dead many hours. It is still in what the taxidermist or bird-stuffer calls, ' a perfectly fresh condition.'

VARIOUS COLOURS OF THE IRIS.

Many of you know that the coloured part of an eye is called the *iris*. The colour varies to a considerable extent, not only in our own eyes but also in those of birds. In the Herring-Gull on the table, we see that it is straw-coloured. In the Jay it is sky-blue; in the Cormorant it is emerald-green; in the Sparrow-Hawk it is brilliant orange; in the Jackdaw it is ivory-white; in the Coot it is rich ruby-crimson; while in a vast number of species it is so very dark in shade that it is almost indistinguishable from the black centre known as the *pupil*. (Pl. II.)

THE EARS.

Let us now look for the ears of our specimen. After some little hunting through the feathers of the face we have discovered them. Note, they are those curious holes each below and behind the corresponding eye, each partly overlapped by a small valve-like fold of delicate skin clothed with fine hair-like feathers: each hole leads into an ear-canal. We have also ear-canals but they are surrounded each by an external projecting ear which catches the waves of sound. Mammals, for the most part, possess external ears. In some classes they are very large, long, and capable of a wide range of movement. When a rabbit or hare is not frightened it allows its ears to fall down on the head. When alarmed it pricks them up and carries them forwards to catch the sound of an approaching enemy. A cat when fighting lowers and pulls its ears backwards out of the way of the teeth or claws of its adversary: at rest however, the ears always stand erect. Their movements are more restricted in range than those of hares or rabbits. Our own external ears are immovable. Only very exceptional persons can exhibit movement, and even then

it is extremely limited. Birds have no external ears whereby to catch the sound in the first instance ; nevertheless their hearing is well-developed. Owls have large valve-like folds of skin which are sometimes spoken of as flaps. These are somewhat moveable, so that at times we can detect the weird manner in which the face appears to retreat and advance. The tufts which spring from the top of the head in certain species of owls and many other kinds of birds, are not ears ; they are just attractive ornaments. The Long-eared Owl, the Short-eared Owl, the Eared Grebe, the Pheasant, the Peacock, the Prairie-Fowl, and many other birds, are possessors of these false ' ears.' I do not think that a bird can hear as keenly at a distance as can many mammals, which have large external ears, such as rabbits, donkeys, and wolves. (PL.II.)

LOCATION OF SOUND.

But a bird is wonderfully accurate in judging the exact point whence the sound comes. One day, when surveying a small island, I heard a redshank piping on the opposite beach. I could not however see the bird because hilly ground intercepted the view. I crouched low under the shadow of a rock and, remaining quite motionless, started to imitate the wild, though very mellow, musical cry. Next moment the redshank took wing and flew towards me ; as I continued to whistle it replied ; then in an instant it swooped down and alighted almost at my feet. It was not until I made a movement with my foot and betrayed my presence at an astonishingly close range that my piping companion became terribly alarmed and, like a flash, beat a hasty retreat ! Owing to its very accurate judgment of sound a bird, on hearing the call-notes, can easily locate its companions when they are at first too far away to be seen. We hear a thrush singing in a

big tree with wide-spreading branches, and although not hidden from view by foliage we often find it difficult to see the minstrel. Furthermore, we are often much in error as to the actual spot whence the voice proceeds. "Let's pretend" that I am as small as a thrush and am singing up in a high tree, and that the thrush is the listener on the ground. I venture to say that my feathered companion would find no difficulty in locating immediately the exact branch on which I stood.

THE NOSE.

Now we shall take a look at the bird's nose. Perhaps you wonder where it is. It would be a nice test for a beginner studying birds to find at once the nose of a crow, jackdaw, magpie, jay, or other members of the tribe. In such birds it is thickly covered with bristle-like feathers which are spread tightly over it and completely occlude it from view. (PL. II. N.) In the generality of birds however the nose is visible in the form of two small holes or slits at the base of the beak. In several species these nasal apertures are more than half-roofed over by scale-like processes or else by tufts of thick recurved feathers. After all, has a bird a nose in the sense that we usually understand it? No; hardly so. It must however be admitted that the apertures in the upper segment of the beak correspond to, and function as, nostrils. In our Herring-Gull we see that they are relatively large, elongated, and not at all hidden by scales or feather-tufts.

TUBULAR NOSTRILS.

It is only in the ocean-birds, called Petrels—including the tiny Storm-Petrel on the one hand, and the leviathan Albatross on the other hand—that we find nostrils elevated and tubular in form. Strange to say, another mighty sea-bird,

namely the Gannet, which is as large as a goose, has no nostrils at all ! How has it come about that a bird possesses only these two little holes in the beak ? Can it breathe and smell adequately ? (PL. II.)

SENSE OF SMELL.

Let it be observed, in the first instance, that a great nose like ours, if built up upon the beak, would be very much in the way ; more important still is the fact that birds *see* so wonderfully well and thereby find food so readily, that their sense of smell need not be nearly so highly-developed as in mammals. Indeed, the smelling-power of birds is, generally speaking, somewhat feeble. The sense of smell was formerly thought to be very acute in some birds. Vultures were supposed to scent carrion afar off ; the wary Curlew evaded the gunner by detecting the odour of gunpowder from the barrels of his fowling-piece. These arguments are fallacious.

THE VULTURE'S SCENT.

A paper-covered parcel containing decaying meat was presented to a captive vulture. The hungry scavenger took no notice of the offering, even when a small aperture was made in the paper to allow some of the odour to escape. It was not until the parcel was opened to a considerable extent and the meat well exposed, that the vulture instantly tore the wrapper to shreds and greedily devoured the contents. It was formerly surmised that when a vulture appeared afar off, like a speck in the sky, it was being attracted by the smell of a carcase lying in the desert. However, more recently, observations by the aid of a telescope, shewed that many other vultures were seen following the trail so far away that the most pungent scent could not possibly have guided them.

These valuable observations proved undoubtedly that the rear-guard—that is to say the birds afar off—through their wonderfully long and powerful vision had become acquainted with the mission of the birds in the vanguard and consequently they followed it up.

GULLS ASTERN.

Some of us, no doubt have often fed gulls from the stern of a steamer. What usually happens? Small parties which leisurely follow the vessel in beautifully buoyant, sailing, and gliding flight, suddenly swoop down with great velocity to the waves: this change of wing-movement attracts others which, owing to our relatively short range of vision, seem at first to come from nowhere; presently others, and yet others, come on the scene, until at length we behold a long stream or procession, as far distant as our eyes can possibly detect it, heading towards the steamer. The birds afar off understood by the hurried flight of those ahead that pursuit for food was the object in view. These gulls, without their wonderfully powerful, keen, and long vision, could never have congregated round the stern of our steamer in such great numbers and in such a very brief period of time.

CURLEWS AND GUNPOWDER.

In regard to the fallacy that birds can smell gunpowder, I may say that I have more than once put this to the test by throwing some recently emptied cartridges, smelling pungently, on marshy ground where curlews were feeding, and have even deposited among them my gun, smelling strongly of spent ammunition. After patiently waiting in ambush until the birds returned, I observed that they began to feed unconcernedly, though from time to time they inspected the fowling-piece

with some degree of curiosity. The story is very different when the birds *see the gunner armed with his gun and prepared for action*: then their sense of vision permits them to discriminate, and so they immediately move clear of the danger-zone. It is the advent of the gunner at gunshot range (which the curlews learn to calculate to a nicety), and not the smell of the powder at that distance (about forty yards off), which gives the signal to decamp.

THE BEAK.

Let us turn our attention to the beak of our Herring-Gull. As in the case of most birds it projects some distance forwards from the face and ends in a strong point. Many of you know already that there is a wide difference in the form of the beak according to the class of bird to which it belongs. Some beaks are quite short, others are long; some are pointed, others are blunted or rounded off at their ends; some are straight, others are upturned; others bent downwards; all beautifully adapted to serve their particular want. There is one feature however, common to the beak of all birds now existing, namely, that it contains no teeth. An approach to teeth is to be found in certain sea-birds: in the mergansers, allied to the ducks, the beak is notched resembling closely the teeth of a saw, and it is admirably adapted for holding the slippery fish upon which the bird feeds. We may say that the point of the beak corresponds in its use to our front-teeth, in laying hold, in the first instance, of the food, which is then passed to the back of the mouth. We, who are provided with back-teeth, roll and chew our food before we swallow it; birds have no structures in their mouth corresponding to back-teeth, hence their food is swallowed in much the same condition as when it entered the mouth. The question then arises—How is the food softened and rendered fit for digestion?

THE GIZZARD AND BACK-TEETH.

Who has not at one time or another peeped into the kitchen and seen the gizzard of a fowl being split open and then cleaned out by the cook ? What a large number of little stones it contains ! Are you surprised to learn that these serve the purpose of the bird's back-teeth ? By the churning action of the very strong muscular wall of the gizzard the stones are set in motion so that they grind and ' chew ' hard corn and other food-stuffs into a soft pulp ; this material is then passed on to the intestine for further digestion. Later on we shall " pretend " to see the gizzard and other internal organs. At present, however, we shall not open our Herring-Gull, but content ourselves by examining some external structures. It may, however, at this juncture, be noted that most birds which live upon soft vegetable and animal food which requires no grinding, have only feebly-developed gizzards. Such species, having swallowed their food, can digest it without the use of grinding-stones, just as we can swallow bread, softened in milk, without using our back-teeth.

THE BEAK AN ALL-ROUND TOOL.

The beak is fitted as an all-round tool for gathering food. Remember that a bird has no free fingers to hold, no claws to seize, (apart from the use which parrots and birds-of-prey and some others make of their toes, here also called claws), and no paws to burrow and root. The beak is the instrument which is called upon to do all these things. That is why a bird, in searching for insects, etc., which lurk in creaks and crannies in old walls, under leaves, and behind the bark of trees, uses its beak with great dexterity and rapidity ; now as a bradawl ; now as a pickaxe ; next

as a pair of scissors ; a pincers ; or other instrument. In a subsequent chapter, when we study the bird in its natural haunts, we shall be amazed to learn about the rapidity and freedom of the movement of the beak. Here, however, we can learn by handling our dead specimen that the free movement of the beak is dependent upon the free movement of the head upon the neck. Of course you will readily understand that we are not referring to the opening and shutting of the two segments of the beak, which, by the way, are also very freely and rapidly performed.

FREE MOVEMENT OF THE HEAD AND NECK.

“ Let’s pretend ” that we have all assembled round the table a day later for the purpose of continuing the examination of our Herring-Gull, as yet undissected. The bird will be more than twenty-four hours dead, and the stiffness, which set in shortly after death, will have completely passed off. Place the bird on the side of the table so as to allow the head and neck to hang freely over the edge. Hold the lower part of the neck with one hand and with the other hand turn the head. Did you feel a trifle timid lest the head might have come right off ? Certainly, you turned it almost through three-quarters of a circle ! It is very amusing when visiting the Zoo, to view that wise-looking creature the owl from behind. On rousing him from his slumbers he will rotate his head through half a circle so that you and he stand face to face. What a curious spectacle ! The back of a bird surmounted by a face ! Those great Eagle-Owls, with their orange eyes and long head-tufts (so-called ears), do look screamingly funny when viewed from that aspect. (Fig. 3.) Let each of you rotate your own head ; note that the movement permitted is much more limited. The middle of your chin can hardly

be brought in line with the point of your shoulder. Indeed the axis of rotation is limited to about 60° .

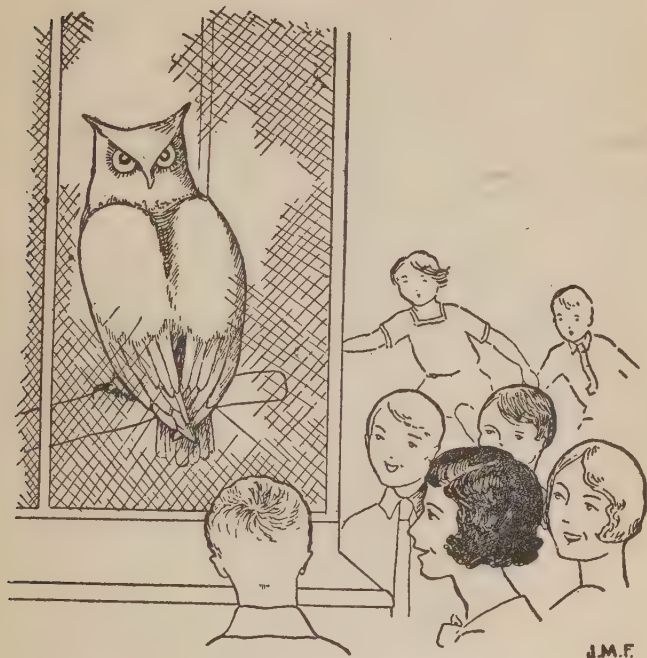


FIG. 3.—THE BACK-TO-FRONT OWL AT THE ZOO.

"What a curious spectacle! The back of a bird surmounted by a face!"

The up-and-down as well as the lateral movements of the bird's head upon its neck are likewise astonishingly free. A little bird with a very short beak can almost preen the feathers of its chin!

COILING OF THE NECK.

Now place the bird on the middle of the table ; you will find by pressing upon the crown of the head that the neck will coil forwards and at the same time sink snugly into a cleft situated at the top of the breast-bone. Our Herring-Gull, with its head sunk between its shoulders, then appears very short-necked. Birds, when resting, usually carry the head sunk between the shoulders. It is only when we examine a plucked bird, or better still, one which has been skinned, that we can properly appreciate the full length of the neck.

But, my young friends, it is advisable at this stage to adjourn the examination of our dead Herring-Gull. In the next chapter we shall commence our studies of the bony framework. In the meantime, if you are afforded the opportunity, just take a look at a bird's skeleton : failing that, you might learn a few interesting points from a good picture. It is always helpful to have at least a general knowledge of some of the bones beforehand.

LECTURE 2.

CHAPTER III.

THE BONY FRAMEWORK OF THE BODY

The Herring-Gull pickled for further use—More observations on the bird's neck—Alice finds her croquet mallet unmanageable—Neck-bones—Vertebræ—Variable in number—Saddle-shaped joints—Extensive range of movement—Examination of the articulated skeleton—Skull—Chief features—Extremely light in weight—Vertebral column—Rigidity and strength—Back-Bone—Range of movement limited—Tail-bones small and few in number—'Ploughshare'—Tail only a stump—Long tail depends upon feathers—Fossil bird with long chain of tail-bones—Breast-Bone—Great size and deep keel—Clavicles—Furculum—'Wish-bone'—Coracoids—Scapulae—Characters—'Handle and Scythe'—Ribs—Pelvis—Ilium—Ischium—Pubis—Architecture and form peculiarly adaptable—Expulsion of large egg—Unyielding shell—Enormous size of breast-muscles—The down-stroke of the wing—Boat-shape of the body—Ballast—Muscle, flesh, and meat—The purport of muscles—How joints are moved—Summary.

“LET'S pretend” that we have utilised some chemical which has preserved our Herring-Gull, so that it is just as useful for examination purposes as when it was first obtained. We recollect how very freely the head of the bird moves on the neck, also that the neck itself is very flexible and can be coiled up and lodged in a notch situated at the top of the breast-bone. Nearly all birds can make their necks appear very short. Many of our notably long-necked species form no exception to this rule. A heron or a bittern will stand motionless for a long time with its head well sunk

between its shoulders so as to avoid being observed. There are however some birds which can only partly sink their extremely long necks between their shoulders but nevertheless can lower them by bending them into a double or S-shaped curve. Their necks always look long whether coiled or straightened out. The Swan, a familiar figure on our ornamental ponds, affords a good example.

THE FLAMINGO OF 'WONDERLAND.'

That extraordinary bird the Flamingo, not a far-removed cousin of a goose, (though furnished with immensely longer legs and neck, and with a strong thick beak so sharply bent that the outer part seems to be set at right angles to the basal part), coils up its neck at times in the same serpentine manner as a swan. The Flamingo has also an extremely flexible neck. You remember that when Alice played croquet in 'Wonderland' she made use of that bird's neck for a croquet-mallet and of a hedgehog for a ball. She succeeded quite easily in getting the bird's rigid body tucked away comfortably enough under her arm, its long legs hanging down, but just as she got the neck nicely straightened out and, with the head, was about to hit the hedgehog, the bird insisted on twisting round its neck and looking up in her face with such an expression of wonder that she could not help bursting out laughing. Yes; Alice found that her Flamingo's neck was rather too flexible on that memorable occasion! (Fig. 4.) What mechanism allows the bird's neck to enjoy such free movement? In the first place you will observe that it is jointed. Now turn to the skeleton which, in addition to our dead, pickled Herring-Gull, I have put upon the table to-day. We notice that the neck is composed of several small bones movably jointed, forming a chain. (Fig. 6, nv.)

NECK-BONE 'SADDLES.'

The surfaces between two adjacent neck-bones, forming a joint, are saddle-shaped. Observe the pommels of the saddles meet cross-wise, which allows them to roll upon each other in a



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FIG. 4.—THE FLAMINGO OF 'WONDERLAND.'

"Yes; Alice found that her Flamingo's neck was rather too flexible on that memorable occasion!"

free manner. (Fig. 5, s.) A ball-and-socket joint connects the skull with the first neck-bone. The skull itself is very light in weight, otherwise it could not be supported by so long and flexible a neck. It is very interesting to note that the number of bones in the neck varies; but even in the shortest-necked birds they are invariably more numerous than those in our necks. Sixteen or seventeen are usual numbers; our small

garden-birds have as many as ten ; in the Swan and Flamingo they exceed two dozen. In mammals, with very few exceptions, the number of bones in the neck is always constant, namely, seven. In the very long neck of a giraffe, or in the short neck of a pig there are seven neck-bones. Why is a bird's neck so very flexible ? Let me remind you once more that a bird has no free fingers or even front-paws. Therefore (excluding birds-of-prey) the beak is used as an instrument for seeking out and capturing food. Moreover, many birds use their beak to build nests, and all to make their toilet. We have often watched 'Pussy' and 'Bunny' licking

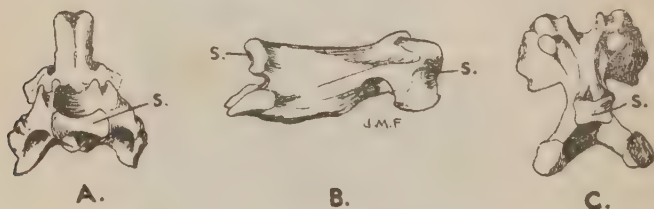


FIG. 5.—THREE NECK-BONES.

The saddle-shaped surface is indicated by S.

A.—Front surface, shewing pommel directed from front to back.

B.—Side view, shewing saddles of front and back surfaces.

C.—Back surface, shewing pommel directed from side to side.

their paws and then rubbing them on their faces. The damp paws are used as washing-pads, for neither cats, nor rabbits, nor many other mammals, ever take a water-bath. On the contrary, birds frequently bathe and wash their face by moving their head on their flexible neck in all directions through the water. Birds also 'dry clean' the feathers of their face by rubbing them on their shoulders. Here again the free movement of the neck comes into play. I shall now put a very important question. In what manner is the neck connected with the body ? It is continuous with the back-bone.

The whole is composed of a series of bones, jointed to one another, and continued backwards directly into the short chain of tail-bones. (Fig. 6, nv., bv., tv.)

For the sake of convenience we name each of these bones a *vertebra*, and when speaking of more than one we say *vertebræ*. Thus we say neck-vertebræ, back-vertebræ and tail-vertebræ. When we wish to speak of the complete chain from the highest neck-bone (which is jointed to the back of the skull) to the lowest tail-bone, we adopt the term *vertebral column*.

THE SKULL.

Before treating of the vertebral column, it is necessary at this juncture, to consider briefly the chief characteristics of the skull. I have indicated already that it is brought into connection with the first neck-vertebra by means of a ball-and-socket joint. The 'ball'—in truth only half a sphere—is situated on the back of the skull, immediately in front of a large hole, called the *foramen magnum*, which permits the spinal cord to enter the interior and become directly continuous with the brain. The 'socket' which is cup-shaped, is situated on the upper surface of the first neck-vertebra. The 'ball' rolls freely in the socket; consequently a highly moveable joint is established, permitting the bird to turn its head in all directions.

I have also mentioned, in passing, that the skull is peculiarly light in weight; otherwise the long, flexible neck could not offer it support. This extreme levity depends not only upon markedly thin shell-like walls, but also upon extensive pneumaticity. In other words, the walls are honey-combed with air-cells. From an evolutionary point of view, the bird's brain has developed apace: hence the

relatively large size of the skull. Nevertheless, the latter is such a feather-weight encasement, that during the hours of slumber it needs no support ; it is never pillowed like that of a mammal. In sleep the bird assumes much the same posture as when awake. It is wonderful to think that the active little brain, which is responsible for an output of energy unsurpassed by any other class of animal, can enjoy adequate repose, while its protecting '*box*' remains standing up, supported on its neck. True, some birds bury the point of their beak amid the feathers of their shoulder ; but even in this attitude any support given to the skull may be regarded as almost negligible.

Following the universal rule, the skull is composed of several bones. But it is noteworthy that—omitting those which participate in the formation of the jaws and some other parts of the framework of the face—they fuse at a remarkably early date. Consequently, the brain-case of quite youthful birds presents a thin, pneumatic, sutureless shell. All the same, within this shell is enclosed quite a roomy cavity, very necessary to give accommodation to a well-developed brain. A great bulk of the brain presides over the organisation of vision. In correlation, we observe that the eye-sockets or *orbits*, immediately in front of the brain-case, are remarkably spacious, and serve to lodge the immense and lustrous 'windows of the soul.' In front of the orbits the face projects pronouncedly—in many birds a long way—constituting the familiar beak, which, as we have noted, varies widely in shape, size, length, thickness, and other features.

The detailed anatomy of the skull constitutes a lengthy and most comprehensive study, which, to embark upon here, would take us too far afield. Suffice it to say that undoubtedly, it will prove profitable, and no less pleasurable, to put into

practise what we have just learned, by handling *the skull* and verifying carefully for ourselves the salient facts above described.

THE VERTEBRAL COLUMN.

Animals which possess a vertebral column are known as *vertebrates*. We are liable to get into the habit of speaking in rather a careless way of vertebrate animals as those which have a *back* bone. The term *back* should refer strictly to the position of the whole vertebral column relative to other structures, and not merely to the region of the back of our body, as we commonly understand it. However, it makes matters much clearer and simpler to define a vertebrate animal as one which possesses a vertebral column. Surely then, a bird is a vertebrate animal ; likewise a fish, a frog, a lizard, a mouse, a man. In most classes of vertebrates all the bones of the column (except a few which are situated between the lower region of the back and the tail, and which are united into a single bone called the *sacrum*), are freely moveable upon one another. Whales, dolphins, and porpoises, among mammals, form interesting exceptions in having their neck-vertebræ fused into one bone. What a contrast therefore is presented between the short stiff necks of these oceanic mammals and the long flexible necks of birds !

FREE MOVEMENT OF THE HUMAN VERTEBRAL COLUMN.

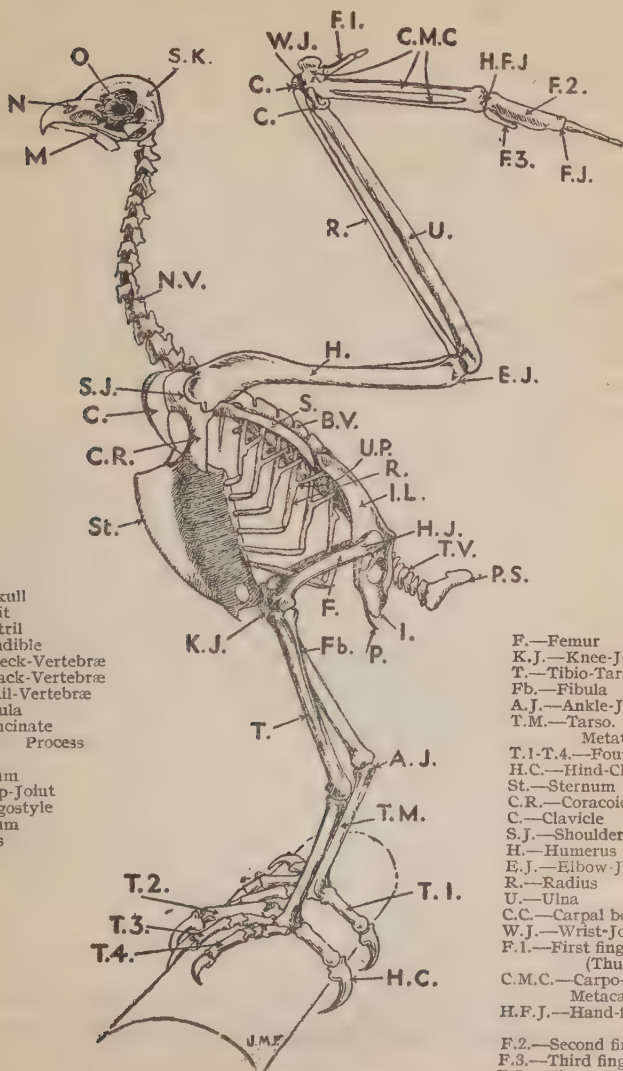
All the bones in our vertebral column move freely except the lower nine ; of these five are fused to form the *sacrum*. succeeded by four, fused to form the *coccyx*. Such mobility explains why in our gymnastic exercises we can bend, twist, and almost wriggle our body in a very free manner, apart from the movements of our limbs. It is true that we have not a long protruding, and flexuous tail to wag like that of

a dog, or to flick briskly over our back like that of a squirrel ; nevertheless the lowest bones of our vertebral column (though minute and reduced to four only in number), represent the remnant of a normal tail. These bones are quite distinct on the human skeleton and, as already mentioned, are called collectively the *coccyx*. (Fig. 14, sa., cx.)

At play the pliant and supple kitten is full of wave-like and spiral movements which sweep along its entire vertebral column from head to tip of tail. The kitten is but one of many mammals which exhibit marked mobility of the vertebral column.

RIGIDITY OF THE VERTEBRAL COLUMN IN BIRDS.

In the bird we have quite another story, for, as far as the vertebral column is concerned, it is only the bones of the neck and tail that are moveable upon one another. Those vertebræ which occupy the entire region of the back have lost their individual movement because they have become welded together in order to afford strength and stability to the body as it cuts swiftly through the air. Hence it is obvious that a bird, unlike a mammal, cannot twist and wriggle its body. Therefore, you see all the more clearly how it has come about that the neck-bones can take on such an extensive range of movement ! But while the bony framework of the bird's back is rigid, we must not run away with the idea that the body itself is correspondingly rigid. Apart from the movements of the limbs on the body and the body on the limbs (with the mechanics of which we shall deal later on), we find that the back-bone is connected with the breast-bone by means of many ribs, the joints of which allow of a considerable range of movement. Many of us have witnessed the pathetic sight of a dying bird in which, in its last convulsive struggles



S.K.—Skull
O.—Orbit
N.—Nostril
M.—Mandible
N.V.—Neck-Vertebrae
B.V.—Back-Vertebrae
T.V.—Tail-Vertebrae
S.—Scapula
U.P.—Uncinate
Process
R.—Rib
I.L.—Ilium
H.J.—Hip-Joint
P.S.—Pygostyle
I.—Ischium
P.—Pubis

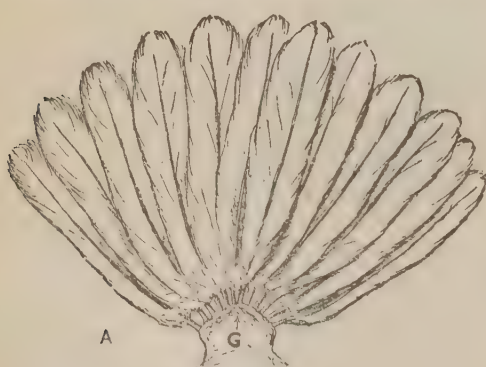
F.—Femur
K.J.—Knee-Joint
T.—Tibio-Tarsus
Fb.—Fibula
A.J.—Ankle-Joint
T.M.—Tarsus
Metatarsus
T.1-T.4.—Four Toes
H.C.—Hind-Claw
St.—Sternum
C.R.—Coracoid
C.—Clavicle
S.J.—Shoulder-Joint
H.—Humerus
E.J.—Elbow-Joint
R.—Radius
U.—Ulna
C.C.—Carpal bones
W.J.—Wrist-Joint
F.1.—First finger
(Thumb)
C.M.C.—Carpo-
Metacarpal
H.F.J.—Hand-finger-
joint
F.2.—Second finger
F.3.—Third finger
F.J.—Finger-Joint

FIG. 6.—SKELETON OF HAWK.

for breath, the heaving movements of its back were greatly accentuated, alas ! sure signs that the end of our little pet's life was drawing to a close. Therefore we see that during ordinary movements of breathing, the bony framework of back and breast enjoy considerable movement. (Fig. 6, bv., r., st.)

THE TAIL-BONES.

Let us now take a look at the bones which form the framework of the tail. It is curious that while there is a little chain of about eight vertebræ, forming a rather short stumpy group, and all freely moveable, nevertheless it is only to the last expanded one that the roots of the tail-feathers are attached.



A.—TAIL OF PIGEON.

Feathers spring from expanded 'ploughshare.'

G.—Oil-gland.

B.—TAIL OF ARCHÆOPTERYX.

Feathers spring in successive pairs from a long chain of tail-bones.



FIG. 7.

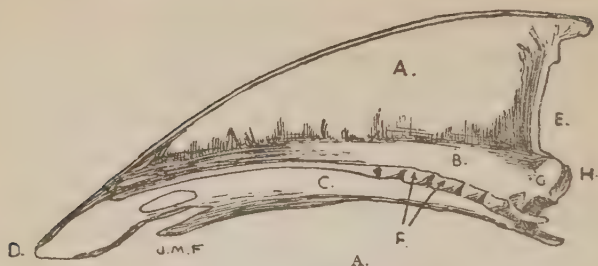
This expanded bone, which is called the *pygostyle* and also has received the quaint name of '*ploughshare*,' is actually

made up of several little bones fused. In the process of fusing they became pressed tightly together and flattened out. If they had remained separate and distinct (as they were before the chick was hatched), then the tail (apart from the length of the feathers), would of course have been much longer; in that respect it would have borne a resemblance to the elongated tail, so commonly found among reptiles and mammals. Remember, the tiniest lizard and its giant cousins the crocodile and alligator have long tails. Likewise among mammals, we can at once think of several long-tailed species, such as the mouse, cat, and kangaroo. Here a long tail signifies a long bony framework, consisting of a great many bones arranged in a long jointed chain like that of the neck or back. When we say that a bird has a long tail, we really mean that it possesses long *tail-feathers*. (Fig. 7, A).

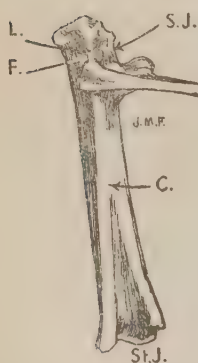
I am here reminded of an extremely interesting matter, namely, the origin of birds traceable from a curious ancestor in which many reptilian characters are discernible. In the rocks there has been found the fossil remains of a creature, named *Archæopteryx*, which possessed wings, a pointed beak-like jaw, armed with teeth, and a long reptilian-like tail: yet the body was clothed with feathers; moreover it is highly interesting to note that the feathers of the tail arose in pairs at different levels from successive pairs of tail-vertebræ, and not, as in the case of existing birds, from the lower edge of the one bone we call the ploughshare. (Fig. 7, B., PL. III.)

THE STERNUM OR BREAST-BONE.

Now, my young friends, try and find out some other features in the framework of the bird's body besides its rigid back-bone. Turn your attention for a few moments to the opposite region, namely, the breast.

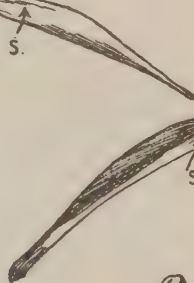


STERNUM OF TERN.



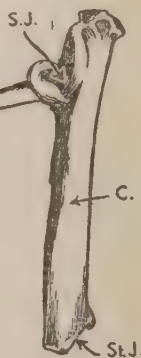
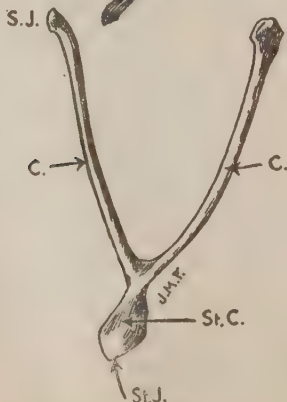
A.—Keel
B.—Under surface
C.—Upper surface
D.—Back edge

E.—Front edge
F.—Facets for Ribs
G.—Facet for Coracoid
H.—Facet for Clavicle



B.
CORACOID AND
SCAPULA OF FOWL.
(inside view)

C.—Coracoid
St.J.—Facet for Sternum.
S.J.—Shoulder-Joint
F.—Ring
L.—Ligament
S.—Scapula.
Obs.—Lesser Breast-Muscle passes under L. and through F to reach Humerus.



C.
CORACOID AND
SCAPULA OF FOWL.
(outside view)

C.—Coracoid.
St.J.—Facet for Sternum.
S.J.—Shoulder-Joint.
S.—Scapula.

D.
UNITED CLAVICLES
OR FURCULUM OF FOWL.

C.C.—Clavicles
St.C.—Stem of Clavicles
St.J.—Facet for Sternum.
S.J.—Facets for Scapula and Coracoid at Shoulder-Joint

FIG. 8.

In our Herring-Gull which lies before us, still unopened, still unskinned, and thickly clothed in its feathers, we can feel the prominent keel of the breast-bone or *sternum*. (Fig.8.A.a.)

This keel, with its attached breast-muscles, imparts to the body its well-known boat-shaped contour. Unlike our breast-bone, which is small, narrow, flat, and about the length of the blade of a dinner-knife, though somewhat broader, and is confined to the region of our chest ; we find that the breast-bone of our Gull, in addition to possessing a deep keel, is so extensive in length and breadth that it reaches far below the region of the chest, indeed in some birds almost to the root of the tail. In this way a very firm bony floor is laid down for the major part of the abdominal cavity, which not only affords great protection for the vital organs, but also, coupled with the strong rigid back-bone, imparts still further strength and stability to the body during flight.

THE CLAVICLES, (FURCULUM). CORACOIDS, AND SCAPULA.
'WISH-BONE.' 'HANDLE AND SCYTHE.'

By closely inspecting the skeleton we see that the upper or front part of the breast-bone is jointed not only to the U-shaped *furculum* or 'wish-bone,' (which represents our two collar-bones, technically called our *clavicles*, joined together) but also to a pair of much thicker and stronger bones called the *coracoids*, which stand out prominently alongside, forming great buttresses which prevent the wings, during their powerful down-stroke, from battering against the side of the body-wall and injuring the vital organs within. Each coracoid proceeds towards the back-bone, and at its dorsal extremity is jointed, forming an angle of about 60° with a long, narrow, *scythe-shaped bone* called the *scapula*. This bone running backwards (in a direction towards the tail), parallel to the long axis of the back-bone, crosses

several ribs. The form of the scapula and coracoid taken together may be compared to a *scythe with its handle*.

In the angle where the 'scythe' makes contact with its 'handle' we notice a great socket which accommodates the head of the upper wing-bone, known as the *humerus*. The head and socket form the bony framework of the shoulder-joint, of which more anon. The mammalian scapula, including our own, is broad and somewhat triangular in shape, and the coracoid is reduced to a small process, fused at one end with the scapula and free at the other end. Our short coracoid is shaped rather like a crow's beak (Greek, *Κόραξ*, raven), and it fails to reach our small, narrow, flat, sternum. There is no need for a great buttress! (Fig. 8, B.C., Fig. 6, cr., c., s., r.)

THE RIBS.

Look next at the ribs. They are well-developed and *bony throughout*. In Man, they are connected to the breast-bone by *cartilages*. Moreover, each avian rib takes part in a threefold freely movable joint: one with the back-bone; one with the breast-bone; and one between two segments of the rib itself. The dorsal segments are much strengthened by remarkable connecting cross-bars or spurs, known as the *uncinate processes*. Muscles acting on these joints can open out the angles between the segments, and thereby greatly increase the dimensions of the body-cavity, a necessary mechanism for breathing purposes. The bony framework of the body of the bird therefore enjoys, as already mentioned, a considerable range of movement. (Fig. 6, r., up.)

THE PELVIC BONES.

In mammals, the hip-bones of either side unite with one another in front (ventrally), and with the lower part of the vertebral column behind (dorsally). In that way a complete

bony rampart is formed, which is lined and floored by muscles, ligaments, and membranes. The whole forms the *pelvis*. This name, in its literal sense meaning a basin, is therefore quite appropriate. Within the pelvis several vital organs are given protection: here also the offspring undergoes development—in birds, hardly beyond the egg-stage; in mammals to completion. The outer walls of the basin grant extensive attachments to muscles, especially those which direct the movements of the lower limbs at the hip-joint. The hip-bones are *composite* in character. In a young animal the three component bones of each are plainly visible, and it is noteworthy that they converge in order to take part in the formation of the deep, cup-shaped socket, called the *acetabulum* (Latin, a little vinegar pot), in which the head of the thigh-bone (forming more than half a sphere), is lodged. Here the hip-joint is formed. (Fig. 9. a.) The expanded part of either hip-bone which passes forwards (towards the animal's head), from the acetabulum, and which unites with the lower part of the vertebral column, is the *ilium*: the part which projects backwards from the acetabulum, and in Man is thick and buttressed, in order to give support in the sitting posture, is the *ischium*: the smaller part which is carried inwards to meet its fellow in the middle line, on the ventral side of the body, is the *pubis*. Remember, each part represents a complete bone, separate in the young animal; completely fused in the adult.

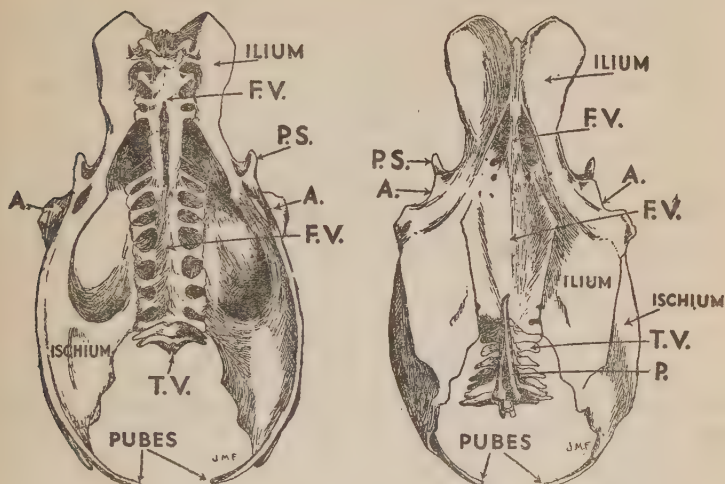
In birds the ilium is *extremely long* and joins many united, immovable, vertebræ, both behind and in front of the hip-joint. This extensive union greatly enhances the strength and stability of the bony framework of the body. The *ischium* is not buttressed. On the contrary, it is represented in a large measure by a thin plate of bone, which projects for

a considerable distance backwards from the acetabulum. Immediately behind the latter, we observe a large aperture which transmits important structures passing from the pelvis into the thigh. Both ilium and ischium enter into the formation of the margins of this aperture. (Fig. 9.)

The *pubis* is a very narrow, slender, rod-shaped bone. Its fused minor part projects a short way in front of the hip-joint, below the ilium. Its free major portion runs a long way backwards, almost parallel with the lower border of the *ischium*, and then curving inwards round its posterior extremity, approaches its fellow ventrally on the opposite side. The free posterior extremities however never meet—except in the case of the ostrich—indeed a wide gap, varying proportionately in different birds, separates the two points of bone. (Fig. 9, C.)

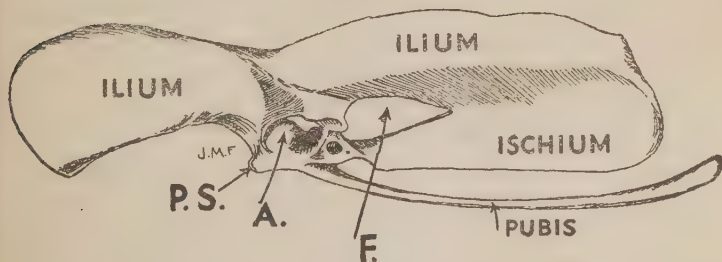
Here it is extremely interesting to observe that in the bird, the ribs extend so far back (towards the tail), and the ilium so far forwards (towards the head), that the latter overlaps several of the former. Furthermore, the front border of the ilium and the lowest point of the long scythe-shaped scapula meet, and in some birds actually overlap. In Man the contrast is very striking: a wide interval exists between the lowest rib and the summit or 'crest' of the ilium. Far greater still is the space which separates the latter from the lower end of the characteristically short, triangular, expanded scapula. (Figs. 14, 16.)

Look at the skeletons of Man and Bird, my young friends, and verify these fascinating anatomical facts for yourselves. The specialised form of the avian pelvis serves its purpose very beautifully. The firm union of the peculiarly long ilium with many fused vertebræ, imparts immense rigidity and strength to the trunk of the body. This is a factor of



A.—VIEWED FROM WITHIN.
(Under walls)

B.—VIEWED FROM WITHOUT.
(Upper walls)



C.—VIEWED FROM LEFT SIDE.

A.—Acetabulum. P.S.—Pectineal Spine. P.—Pygostyle. T.V.—Tail-Vertebrae.
F.V.—Fused Vertebrae. F.—Foramen or passage into thigh.

FIG. 9.—PELVIS OF THE FOWL.

primary importance in the mechanism of *flight*. The extensive area of the bony rampart permits several massive muscles which move the lower limb, to gain attachment to its outer walls. Muscles which move the trunk and tail find room also for their attachments.

Lastly ; the remarkably long, slender, rod-like, elastic, pubic bones, free not only at their extremities, but also for the major part of their length, are capable of wide separation during the extrusion of the very large egg, heavily laden with yolk and albumen.

Here then is presented a strikingly beautiful adaptation, in which a very precious germ, provided with a vast store of nutritive material, the whole a bulky mass enclosed in a calcareous, unyielding, albeit fragile shell, can be expelled from the pelvic-cavity gradually and very steadily, without fear of being damaged.

IMMENSELY POWERFUL MUSCLES.

I should like you to feel for yourselves the breast of our Gull. It is very firm to the touch. That is because it is composed almost entirely of two immensely powerful and large muscles. They must be powerful to bring about the down-strokes of the wings in flight. We can determine by the sense of touch that these muscles are attached to the breast-bone. The surfaces for their attachments, already very extensive, are rendered all the more so by the presence of the deep keel. These muscles are tremendously powerful, especially in heavy birds which, with short wings, can fly at a rapid rate. In some species the great breast-muscles weigh as much as the rest of the muscles of the body put together ! Our breast-muscles, which pull down our arms, weigh only the one-hundredth part of the combined weight of the other muscles !

Here we notice a very pretty point. You are aware that in order to minimise the risk of a boat being capsized, its keel must be adequately weighted, either by attaching heavy metal to it or by filling the hollow of the inside of the boat (which we generally call the *hold*), with heavy material. The attachments of the great breast-muscles to the under surface and to the keel of the breast-bone, together with the weight of the heavy organs which impinge against its upper concave surface, serve the same purpose in the case of the boat-shaped body of the bird. (Fig. 34.)

WHAT ARE MUSCLES ?

I want you to be quite clear in regard to what is understood by *muscles*. We shall have much more to say on a future occasion about these wonderful structures, when dealing with flight and other movements. The muscles and the flesh of an animal are one and the same thing. We call the muscles of animals which we use for food *meat*, though the term is not so universally adopted when we speak of the flesh of fishes and fowls. Nevertheless, bird's muscle is *meat*.

AN ANATOMICAL DISCOURSE AT DINNER.

"Let's pretend " that we have put away our Herring-Gull in pickle for the moment, and that we are now sitting down to enjoy our dinner.

Just look at the *breast* of the chicken *before* I carve slices. Omitting the skin, and perhaps a thin layer of fat, we see that it is composed of breast-muscles or chicken-flesh. On the other hand you must exercise a little patience until *after* I have carved a slice or two off the ham, because we cannot see the muscles properly unless we obtain a clean cut surface. Look now ! The meat, apart from intervening

fat, is arranged into several distinct masses, separated from one another by membrane and some fat. Each mass is part of a muscle seen in section, which has been severed from the other part on removing the leg of the carcase from the trunk. In life, these masses of flesh or muscles have the power of contraction, that is to say of shortening; consequently, when they are attached from one bone to another they can move the joint connecting the two bones. (Fig. 27.) Muscles can contract or wrinkle the skin causing the feathers to stand up: they can also act upon other structures of the body.

SUMMARY.

Before passing on to the bony framework of the wings and hind-limbs, which we shall consider in the succeeding two chapters, let us sum up the main points which we have been studying. We have put our Herring-Gull away in its pickling jar because we shall not require it again for the present.

The neck of birds, whether long or short, is extremely flexible, and is composed of a varying number of vertebræ which individually have very free and extensive movements. Hence the neck can be coiled up and shot out almost with the speed of a serpent's strike. The ball-and-socket-joint connecting the neck with the extremely light skull, permits of very free movement. Consequently, the beak is allowed to carry out successfully its business of 'Jack-of-all-trades.' The bony framework of the trunk of the body (as distinguished from the head, neck, tail, and limbs) on the other hand, depends upon the action of the ribs mainly for its movement. The back-bone (considered as a part only of the vertebral column), is almost immovable, because its vertebræ are fused together. Therefore twisting and wriggling movements of the trunk are

not permitted. The loss of movements in these directions is more than compensated by the stability and strength which is gained. The rigidity of the back-bone denies a little bird, when held in the hand, the power of wriggling in its bid for liberty. We know to what a very appreciable extent a mammal, and more particularly a reptile, can wriggle when trying to escape from the hand. Nothing is easier than to carry a fowl or a duck *under one's arm*, and the same applies to wild game-birds and others of similar dimensions. Remember once more, that it was the neck only of the Flamingo which caused Alice so much anxiety. This self-sacrificing bird, even when used most energetically as a croquet-mallet, suffered its body to remain comfortably tucked away under the arm of the little girl croquet player ! The tail is freely movable, and apart from the faculty which the bird possesses, of moving the feathers individually at their attachments to the 'ploughshare' bone (a matter which we shall look into more fully later on when dealing with flight and plumage), we must bear in mind that the eight little tail-vertebræ are, just like the neck-vertebræ, very movable in relation to one another, so that elevation, depression, and rotation of the tail-feathers can follow. The length of the bony framework of most birds' tails is constant in proportion to the size of the body. We seldom appreciate this point owing to the fact that a thick coating of longer or shorter feathers covering the tail (technically called *tail-coverts*), masks the extent and contour of the tail-vertebræ. On the other hand, apart from the bony framework, the true tail-feathers which usually project beyond the coverts (though not so in the case of the Peacock and some other birds), and are commonly called the *tail* of the bird, vary to a very considerable extent, even in species closely related. Compare for instance, the marked difference

in the length of the *tail* of the Long-tailed Tit and the Blue Tit, or of the Magpie and the Jackdaw.

I may close this chapter by telling you that situated over the roots of the tail-feathers is a small, soft, pale yellow, wart-like process : this is an oil-gland, which the bird can easily reach with its beak, owing to the length and flexibility of its neck. The oil is utilised from time to time for the purpose of preening the feathers. (Fig. 7, A.g.)

CHAPTER IV.

THE BONY FRAMEWORK OF THE WINGS.

Number of limbs in a typical vertebrate animal, always four—Suppression of hind-limbs in some classes—Whales, dolphins, porpoises—The super-added limbs of mythical vertebrates—The Gryphon of 'Wonderland'—Limbs built on a uniform plan—Various names given to front-limbs—Comparison of bony framework of wing of Bird with arm of Man—The Humerus and shoulder-joint—The Ulna—Radius, and elbow-joint—The Carpals and the wrist-joint—The hand and finger-bones—Carpo-metacarpals—The Phalanges, and their joints—Peculiarities of the wing-bones—Reduction in number and fusion of wrist, hand, and finger-bones—Absence of free movable finger-bones—Thumb-bones separate but exceedingly small—No turning movement at elbow-joint—Palms of bird's hands face each other—Movement of edge of hand on wrist remarkably free—180 degrees—Corresponding movements in the human hand—45 degrees—The shutting of a blade of a penknife—A close simile—Movements at shoulder-joint exceedingly free in both Bird and Man—Purely hinge-joint at avian elbow—Summary of the main differences in the bones of human arm and avian wing—The skewering of a chicken—Why dinner was delayed.

THESE are scores of interesting points to learn in regard to the bony framework of the wings of the bird. With the mounted skeleton before us we shall be able to use it as a key in determining the framework in the wing of our undissected Herring-Gull. In other words, having studied the bones on the skeleton, we shall be able by the sense of touch to study them on the undissected dead bird. In the first place we must bear in mind that in all vertebrate animals there are never more than four limbs present. True, there may be fewer: for instance, the Whale,

Dolphin, and Porpoise, possess only the two front-limbs ; hind-limbs would be in the way of the huge mobile tail. They might indeed impede its powerful and swift action as it lashes and churns up the water after the fashion of the propeller or 'screw' of a steam-ship. Hence the hind-limbs have quite disappeared in these mighty denizens of the deep. The snake has become altogether limbless and, it is thereby enabled to glide noiselessly and with greater subtleness through dense and entangled vegetation. Of course it should be remembered that the wings of the bird are not to be regarded as super-added structures : they are actually the front-limbs themselves, altered in certain directions for the purposes of flight. They correspond, as we shall see more fully presently, to our own front-limbs which we call arms, including our hands and fingers.

THE GRYPHON OF 'WONDERLAND.'

It is only in mythical vertebrate animals that wings are present in addition to the front-limbs. Such creatures are portrayed as having six limbs ; in other words the same number as there are legs in an insect ! If you have a copy of "Alice in Wonderland" just take a look at the picture of the Gryphon as soon as possible. This monster has the hind-limbs of a lion, the hind-limbs of a bird armed with dreadfully formidable looking talons (these limbs being situated in the position of front-limbs), and a pair of wings of a bird ! It is important to bear in mind that the limbs of vertebrate animals are framed upon a uniform plan. We speak of the front-limb of a man as an 'arm' ; of a bird and of a bat as a 'wing' ; of a horse as a front-'leg' ; of a dog, a cat, a rabbit, as a 'paw' ; of a whale as a 'flipper' ; of a fish as a 'fin.' On the other hand, the hind-limb (except in the

case of a fish when it is also called a fin), is spoken of invariably as the leg. Yet hind-limbs as well as front-limbs are subjected to modification in form and structure. Apart from the fact that the wing is endowed with a wonderful system of feathers (the use of which shall be considered more fully



FIG. 10.—THE GRYPHON OF 'WONDERLAND.'

Reproduced from Carroll's "Alice's Adventures in Wonderland,"
by kind permission of Messrs Macmillan & Co. Ltd.

*"This monster has the hind-limbs of a lion, the hind-limbs of a bird,
....and a pair of wings of a bird!"*

later on in connection with our studies on *flight and plumage*) I hope now to make it clear that its fundamental framework bears as close a comparison with that of our arm as the framework of the bird's leg bears with that of our leg.

THE HUMERUS, ULNA, RADIUS.

"Let's pretend" that we are now carefully examining the wing-bones on the skeleton of a bird and the arm-bones on the human skeleton. In both you will observe a single

long bone of considerable strength, more particularly so in the bird. This bone, named the *humerus*, at its upper extremity connects the wing to the body in the bird, and the arm to the body in the man, at their respective shoulder-joints. Look next at its opposite or lower end. Here it is brought into connection with two other long bones at the elbow-joint. You hardly would have thought that a bird had an elbow? Yes it has; and if you move the bones in a skeleton you will find that a to-and-fro or hinge-action takes place. Your own elbow-joint moves in a similar manner. The two long bones, called the *radius* and the *ulna*, held together by ligaments, run down alongside each other from the elbow to the wrist, and, by making contact with a number of variously-shaped little bones, the wrist-joint is formed. (Figs. 14, 16, h., r., u., Fig. 11.)

THE CARPALS, METACARPALS, AND PHALANGES.

I need not burden your memories with the individual names of the small wrist-bones. Collectively, they are known as the *carpals*. But carefully observe, eight are present in the wrist of Man, and only two in that of the Bird. Why? Because the bird in using its wrist in flight, will require strength rather more than delicacy and wide variation of movement. This becomes still clearer when we compare the bony framework of the hand in Bird and Man. Remember that we possess four free movable fingers and a very movable thumb. The thumb and fingers taken together are called *digits*. We therefore have five free and movable digits. There are three bones called *phalanges* in each digit except in the case of the thumb, in which there are only two phalanges. Our digits therefore are made up of fourteen bones. Count them on your own fingers; nothing easier!

The bones can be felt readily through the skin and other soft tissues. The framework of the hand, exclusive of the digits, is made up of five bones, elongated in shape. It is difficult to feel these distinctly in the palm because they lie deeply and are

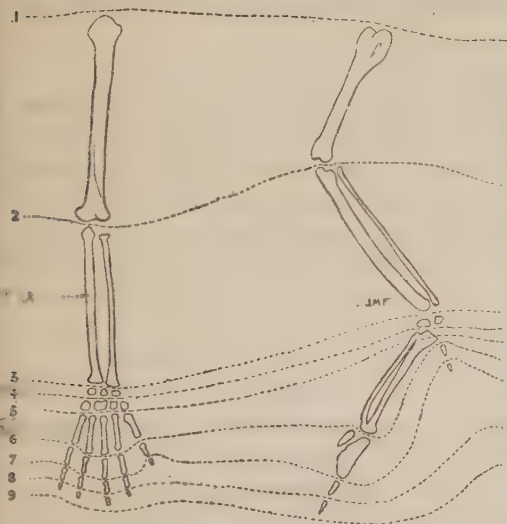


FIG. 11.—THE BONES OF THE FRONT-LIMB IN MAN AND BIRD. The broken lines demarcate the corresponding segments of the limbs.

Observe, in Man, line 5 passes between the lower row of free carpals, (four in number), and the five free metacarpals.

In the Bird this line passes through the upper end of the single carpo-metacarpal bone, in which is incorporated the lower row of carpal bones.

In the Bird, lines 6 and 7 curve abruptly upwards because the thumb-bones are situated a long way above the bones of the second and third fingers.

covered by many structures. But on the back of the hand they can be readily mapped out. These bones are collectively known as the *metacarpals*. At their upper ends they make contact with some of the carpals at the wrist-joint: at their lower ends they are brought into communication with the nearest row of the phalanges. Let us count up. Eight carpal or wrist-bones; five metacarpal or hand-bones; and fourteen phalanges or finger-bones, the thumb being here called a finger. Twenty-seven bones in all: this is a goodly number. Now if we bear in mind that from our wrist to the tips of our fingers these bones are connected by a series of

joints in which movements are varied and for the most part free, it becomes at once clear that the wonderful joint-mechanism of the human hand, with its full complement of bones, is to be associated in the main with movements highly skilled and often delicately performed. (Fig. 16, c., mc., ph., Fig. II.)

THE BONES OF THE AVIAN HAND.

Turn your attention again to the bony framework of the avian hand. The fourth and fifth hand-bones, i.e., metacarpals, have disappeared, together with their corresponding series of finger-bones (i.e., phalanges). Of the three metacarpals remaining, you will note that *all* are united at their bases (where, with two free little carpal bones, they make connection with the wrist-joint), but that the one belonging to the thumb alone is free at the far end. Here it is jointed to the nearest of the two phalanges of the thumb-digit. The whole bony framework of the thumb is extremely short and small : hence this digit, though possessing some movement, is a very insignificant entity. The second metacarpal is the strongest. It is straight and of considerable length. The third metacarpal is also elongated, but more slender ; and furthermore, it is curved. It is united with the second at the lower or far end. Obviously then the three metacarpals form but *one bone*. Furthermore, two small carpal bones are fused with its upper end. Therefore the whole bone of the avian hand (less the phalanges) is aptly called the *carpo-metacarpal*. Next let us examine the digits or finger-bones. Calling the thumb a finger, we have already noted that its framework is very small and composed of two bones. One of these however is extremely minute and frequently inseparable. Albeit, when the two phalanges are distinct, the avian and human thumb strictly correspond in the constitution of

their bony framework, and also in having their extremities quite free. The second and third digits (fingers), which commence a long distance down from the thumb, are attached to each other and therefore have practically no independent movement. In the long second digit there are three bones (phalanges) as in the corresponding human finger. Sometimes, however, only two phalanges are present. The third digit is decidedly small and possesses only one short bone (phalanx). Joints in the strict sense are absent from the hand of the bird, although a slight degree of movement is permitted between the two united fingers. To put it shortly ; the bird's hand, unlike that of Man, is bereft of freely moveable fingers. (Fig. 16, c., fr., cmc., f2., f3., Fig. 11.)

CORRESPONDENCE BETWEEN THE BONES OF THE AVIAN WING AND OF THE HUMAN ARM.

All the same, when you examine the limb-bones on the two skeletons it must be quite clear that the bones in a bird's wing and in the human arm can be very closely matched and indeed may be said to correspond. In the bird, I repeat, there has been reduction in the number of the bones of the hand and fingers, and fusion in those which have persisted. When stripped of its feathers the bird's front-limb (its wing), presents a startling resemblance to a human arm. Before that plucked chicken, which, "let's pretend," we now see lying on the kitchen-table, is skewered and put in the pot, pray take a look at the wings as they hang loosely from the body. Just bend the elbow-joint. There! you have a beautiful demonstration of the to-and-fro or hinge-movement. Bend your own elbow-joint. The movement is quite similar, is it not? Here however is a decided difference. The bird is

denied the power of a rotary movement at this joint. So much the better for the bird, for in flight the two bones, the radius and ulna, must keep rigid, because frequently they have to withstand a very great strain indeed. Furthermore, a bird cannot pick up an object with its fingers, hence the turning movement would in that respect serve no useful purpose: indeed it would prove harmful in interfering with the stability of the elbow-joint in flight. Place the palms of your hands upon the table, please, will you? See! in an instant you can reverse the position so that your knuckles are now in contact and your palms look upwards. The movement which allows the hand to be swung round in this fashion takes place mainly at the elbow-joint, but in a distinct and different compartment from that in which hinge or to-and-fro action occurs.

TURNING-ACTION NOT PERMITTED AT THE BIRD'S ELBOW-JOINT.

In the bird, I repeat, that the turning-action is not permitted at the elbow-joint. In picking a chocolate off the table the palm of our hand looks downwards, that is to say faces the table. In conveying the tit-bit to our mouth we turn the hand so that the palm looks upwards. A bird would simply pick up the chocolate in its beak if its taste were so disposed! Remember, in the bird the palms always look inwards towards the body; the backs of the hands outwards; the thumbs upwards (when the hands are extended on the wrist); the third fingers or digits downwards. To render this description quite clear, you have only to bear in mind that the palms of the bird's hands face each other when the wings are folded, but of course the sides of its body prevent these surfaces of the wings from making contact. In the bird it is the *edge* of the hand which travels round the

Limb-Folding Mechanism.



(Plaster models and photos by the Author)

THE LIMBS IN MAN AND BIRD.

- A.—Upper limb (wing) of Bird, shewing extensive border-movement of the hand.
- B.—Upper limb (arm) of Man, movement much more restricted.
- C.—Lower limb (leg) of Bird, shewing extensive movements of ankle and toes.
- D.—Lower limb (leg) of Man, movements much more restricted.

wrist, and there is little or no movement of the surfaces. We can bend our hand forwards so as to bring the palm in a position at right angles to our forearm ; we also can reverse the position so that the back of our hand makes a right angle with our forearm. These movements, popularly known as 'up and down,' and technically as *extension* and *flexion*, (which are permitted in mammals and reptiles with free fingers), are denied the bird. This certainly is the case when the wing is spread : some little movement of the surfaces of the hands however is permitted when the wing is folded.

EXTENSIVE BORDER-MOVEMENT OF THE BIRD'S HAND.

On the contrary, the bending of the edge or border of the hand at the wrist-joint is so free and extensive in the bird that these edges can almost become reversed in position. Thus the lower edge, i.e., opposite to the thumb, moves so far round that it nearly can touch the lower part of the forearm. Put your own hands in a position with your thumb uppermost as though you were about to applaud by clapping : next imagine your fingers measuring three or four times their usual length and joined together : then imagine bending the wrist edgewise so freely that the little finger, and the edge of the hand in line with it, are brought so far round that they almost touch the border of the lower part of the forearm ; then you will have a good idea of the extensive *border-movements* of the bird's wrist-joint. (PL. IV. A.)

PEN-KNIFE ILLUSTRATION.

I can perhaps attempt to illustrate the movement of the bird's hand at the wrist-joint by comparing the forearm, (that is to say, the region below the elbow), to the handle of a penknife, and the hand to its blade. Hold the knife in such a position that the back of the open blade, which we

will say corresponds to the upper edge of the hand (remember the thumb looking upwards), looks upwards; the cutting-edge will then of course look downwards. The latter will correspond

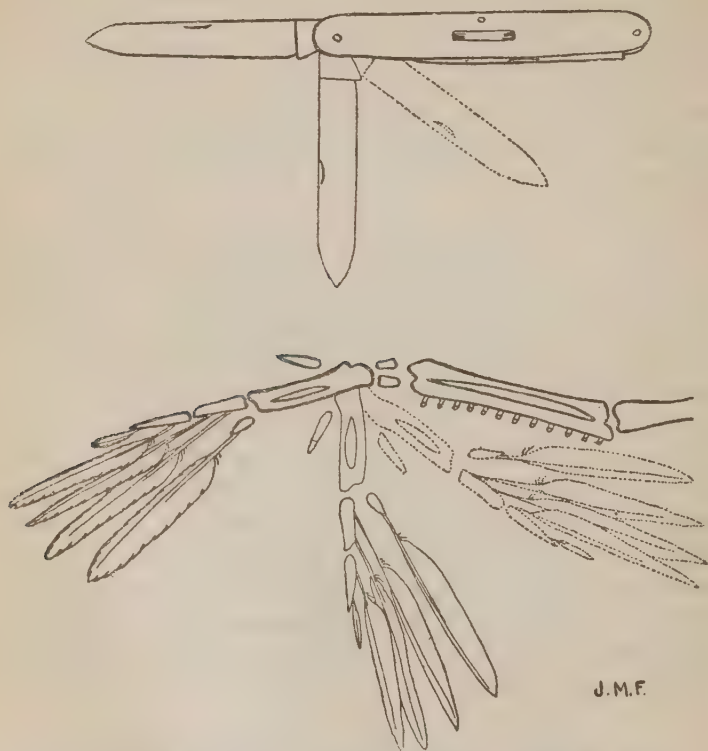


FIG. 12.—ARC DESCRIBED IN CLOSING A PEN-KNIFE AND FOLDING THE BIRD'S HAND ON ITS WRIST.

to the lower or opposite edge of the hand. Holding the knife in this position proceed to close the blade. The form of hinge which permits the blade to be moved on the handle slowly

is much better to adopt in making this experiment than the knife in which the blade closes with a snap. Because in using the latter if one be not careful, the hand may be cut. Now what have we learned ? Surely, that the movement of the blade on the handle corresponds to the movement of the avian hand on the forearm at the wrist-joint. But has not the movement been remarkably extensive : an arc of a circle of nearly 180 degrees has been described ! Look ; the cutting edge of the knife (remember corresponding to the lower edge of the hand) in moving round through half a circle has reversed its position ; it now looks upwards and actually makes contact with the under edge of the handle ! The back of the closed blade, corresponding to the upper edge of the hand which carries the thumb, as a result, looks downwards. (Fig. 12. PL. IV. A.)

LIMITED BORDER-MOVEMENT OF HUMAN HAND.

Finally, will you all just test the range of movement which the lower edge of your own hand makes at the wrist-joint ? Place the hands in position as before ; palms facing ; thumbs looking upwards. Proceed to move the hand as though you wished to bring the lower edge and its little finger nearly into contact with the forearm. No ; it cannot be done. Prove for yourselves that this movement is very limited ; at the most an arc of about 45 degrees can be described. (Fig. 14, mc., PL. IV. B.)

FREE MOVEMENT AT THE SHOULDER-JOINT.

Try now to appreciate by the sense of touch the movements permitted at the bird's shoulder-joint, before the bones and ligaments are laid bare by dissection. Carefully inspect the skeleton immediately beforehand ; then you obtain the key to the situation. Make sure of the position of the humerus : in our Herring-Gull it is thickly clothed with muscles and

other structures. Nevertheless, by grasping the inner part of the wing (i.e., the part near the trunk) with one hand, you can carry the other hand up along the humerus to the shoulder-joint. Move the limb and at once you see that plenty of freedom is permitted. The wing can be carried not only up and down, backwards and forwards, but it also can be rotated to a considerable extent. Certainly, there seems to be no limit to the combination of movements which can be carried out at our own shoulder-joints. Swing your arms about vigorously, my young friends: up, down, in and out, and round about! It is capital exercise! We cannot but feel a sense of pride on learning that our shoulder-joints allow of the most extensive, the most skilled, and the most graceful movements exhibited in our entire set of gymnastic performances.

DIFFERENCES BETWEEN THE WING OF BIRD AND THE ARM OF MAN SUMMARISED.

Having now made a general survey of the bony framework of the avian wing, we have learned that it is built upon the same fundamental plan as that of the human arm.

I shall close this chapter by indicating the chief differences between them, which are dependent upon the different work they are called upon to perform. The average bird's wing (quite apart from the length of the long flight-feathers) is proportionately longer than that of the human arm, and still much longer than the front-limb of mammals in general. However, there are some exceptions, notably observable among monkeys and bats. Here is an interesting point: birds and reptiles have sprung from a common ancestor, yet if we take a lizard and a bird of relative weight and size, you could hardly picture to yourselves anything more extraordinary than the lizard with a front-limb the length of the

wing of the bird ! Avian wing-bones are lighter and stronger relatively than human, and the surfaces of some are proportionately broader in order to give firm attachments to the huge and powerful wing-muscles and the flight-feathers. The hand of the bird is very long and narrow ; its bones, including those of the fingers, are reduced in number, while those which persist are united : consequently the hand cannot be utilised to pick up food and other objects. But remember that union imparts strength and rigidity, which are required



J. M. F.

FIG. 13.—WHY DINNER WAS DELAYED:

"Lose no time in popping the fowl into the pot."

during the powerful strokes of the wing in flight. Rotation or turning movements at the elbow-joint, also backward and forward movements at the wrist-joint are lost ; on the contrary, the side movements at the wrist-joint are much more extensive than in the human wrist-joint. The bending

movements at the shoulder, elbow, and wrist, are so extensive in the bird that the wings when at rest can be neatly folded, thereby allowing contact almost to be made between the upper segment of the arm (*arm proper*, in anatomical language), the lower segment (which we call the forearm), and the hand. The human arm cannot be folded anything like so completely ; the less extensive border-movement at the wrist-joint will not permit it. (PL. IV. A. B., Figs. 14, 16.)

Now my young friends, just as an object-lesson try to fold completely the wings of the plucked chicken which is still lying on the kitchen-table : the operation is perfectly simple : really I do think that one of you had better hasten to drive skewers through the wings while they are so neatly folded ; then be sure to lose no time in popping the fowl into the pot. We are done with the carcass for educational purposes, and I understand that it should have been cooked for dinner three hours ago ! (Fig. 13.)

LECTURE 3.

CHAPTER V.

BONY FRAMEWORK OF THE HIND-LIMBS.

Additional material for comparative study—Regions of the hind-limb—Thigh—Leg—Ankle—Foot—Human and avian-thigh—Hip-joint—Femur—Knee-joint—Tibia—Fibula—Ankle-joint—Tarsals—Joints of the foot and toes—Metatarsals and Phalanges—Special characters of certain bones—The Avian Fibula—Complete absence of free tarsals—Fusion of some with tibia—Tibio-Tarsus—Fusion of other tarsals with metatarsals—Tarso-Metatarsals—Complete disappearance of fifth metatarsal and phalanges—Fusion of other four metatarsals into one bone—Indications that four separate bones once existed—Peculiarities of the first metatarsal—Persistence of four toes or digits—Number of phalanges in each digit—Corresponding number of bones in hind-toe of Bird, big-toe of Man, thumb of Bird and of Man—Second toe and second finger in Bird and Man—Phalanges of third and fourth toes in Bird and in Man—Ratio of number of bones in toes collectively, in Bird higher than in Man—Reversed ratio in finger-bones—Freedom of movement in joints of toes—Movement at avian ankle-joint purely hinge-action—Disappearance of free tarsals an advantage—Movements at human ankle-joint—The slippery orange-peel—Nasty lateral movement—Separate tarsals and metatarsals retained with advantage in the human ankle-joint—Skilled movements.

TODAY, again we have before us a skeleton of a man, and a skeleton of a bird, together with our dead Herring-Gull, the last still beautifully preserved, quite undissected, and with its feathers undisturbed. I think that one of you had better slip out to the larder and ask the cook for a loan of that *plucked* duck which I noticed a few minutes ago hanging up, before it is put into the oven to roast for dinner. The feet of our Herring-Gull have become somewhat dried up by the chemicals with which we have preserved the

body ; therefore we shall place them in a bowl of water for a little while to soften and make them pliable enough to enable us to move the joints. In the meantime we can examine the *bones* of the hind-limbs on the skeletons. In order to understand fully what I have to say about many interesting peculiarities in the leg of the bird (by the term 'leg' I mean of course the entire hind-limb, including thigh, leg proper, foot and toes), I think it would be well to mention one or two points to which I drew your attention in the last chapter. You will remember that a vertebrate animal never possesses more than four limbs, but it may have fewer or indeed none at all ! When the limbs are reduced in number we find it is the hind-limbs that are sacrificed. Hence as we are about to study these, it is fortunate that, in addition to our Herring-Gull and our Duck, we have before us the skeletons of Man and Bird, all furnished with well-developed hind-limbs. Recall to your minds that the front-limb is known by many names : 'arm,' 'paw,' 'front-leg,' 'fore-leg,' 'wing,' 'flipper,' 'fin.' On the contrary, the hind-limb (except in the case of a fish when it is of course called the hind-fin) is invariably called the 'leg.' Anatomically speaking, the term 'leg' must be used in a more restricted sense. We shall have occasion to refer again to this point presently. Now the hind-limb, invariably called in popular language 'leg,' differs as much in detail in different animals as the front-limb with its several names. On the other hand you recollect that the bones of the avian wing and of the human arm, apart from differences of detail, can be closely matched and made strictly to correspond. The main differences in detail are that some of the bird's hand and finger-bones have disappeared, and the rest (barring the minute thumb which needs no further consideration), have become almost united.

Therefore instead of a set of free and movable fingers, which would be not only useless but also an impediment in flight, the bird is provided with a hand made up of *bones, mainly fused*, strong, long, narrow, and tapering to a point; a hand indeed exceptionally rigid; the whole architecture revealing a beautiful adaptation for cutting through the air like a great flail when the powerful down-stroke of the wing is delivered during rapid flight. Having thus seen the points of resemblance between the bird's front-limb and that of our own, which are *primary* and can be accounted for by the kinship which exists between all vertebrate animals; and also having seen the points of difference which are *secondary*, and can be accounted for by differences of function, we are surely in a better position to turn our attention to the study of the hind-limb of the bird and to compare it in the first instance with our own hind-limb. Watch carefully and you will see in what an intimate manner the bones correspond.

"Let's pretend" that we are most carefully examining certain bones in the skeleton of a bird and comparing the same in a human skeleton. The bones of the hind-limbs now claim our attention.

THE HUMAN AND AVIAN THIGH.

In the first instance I would remind you that a special name has been definitely assigned to the upper region of the hind-limb for descriptive purposes, namely, the thigh; that region extends from the hip to the knee. (Figs. 14, 16. f.)

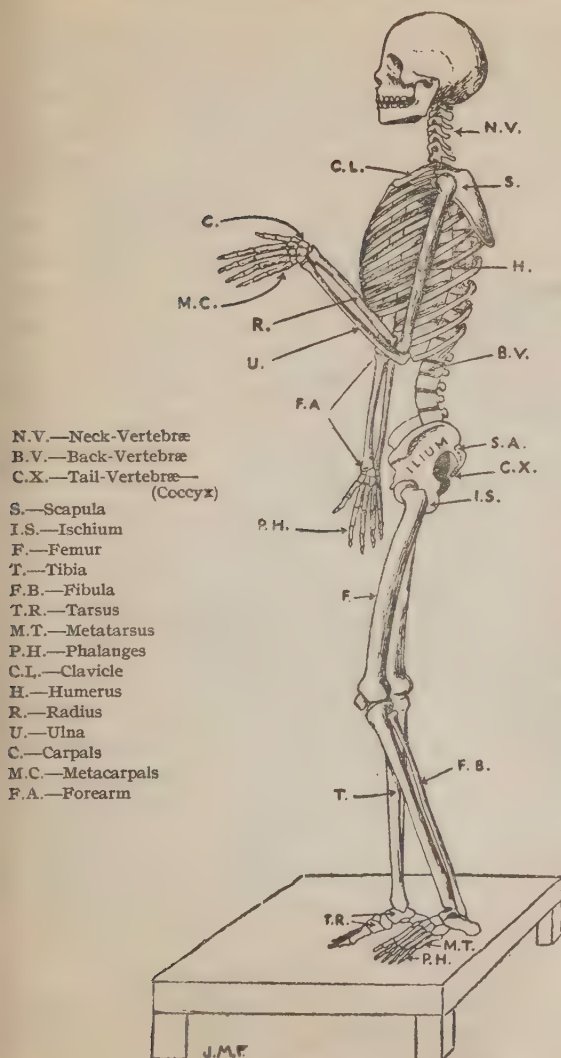
Strictly speaking the term *leg* should be applied to the part of the hind-limb which is situated between the knee and ankle. We saw that the upper region of the human arm and of the bird's wing, that is to say the region between the shoulder

and elbow (called by the anatomist the *arm*) were both of considerable length, consequently the respective bone of each, namely the *humerus*, is also long. It is different in the case of the thigh. This region is *peculiarly long in Man*, but *short in the Bird* and *in most of the lower animals*. Moreover, it is only in Man, when in the standing posture, that the thigh runs vertically downwards, in fact lies in a *straight line* with the body from above downwards. In the Bird whether it be perching on a branch, bouncing over the lawn, racing nimbly along the sands, or standing motionless, the thigh is *always* inclined at an *angle* with the body at the hip-joint, and with the 'leg' at the knee-joint. The thigh is in contact with that part of the body we popularly call the flank, so indeed is the knee, and both are hidden deeply in the feathers. When we stand up our thigh runs away down from our body, hence the knee is remote from it. (Figs. 14, 16.f., hj., kj.)

THE FEMUR, TIBIA, AND FIBULA.

Let us study the arrangement of the bones of the hind-limbs in the skeletons of Man and Bird.

In both you will observe a single bone of considerable strength which at the upper end connects the limb to the body at the hip-joint. The name of this bone is the *femur*. Obviously this is the bone of the thigh; we note how long it is in Man and how short in the Bird. Now examine the opposite or lower end of the femur. Here it is brought into connection with two other long bones at the knee-joint. You hardly would have thought that a bird has a knee, especially as in life it is always hidden away among feathers. Move the hind-limb bones on the skeleton and you will find a corresponding hinge-movement in the knee-joint of Bird and Man. But the two long bones which run down from the knee and



Observe the limited border-movement of the hand at the wrist-joint (C), the great distance between the lower end of the Scapula (S), and the summit of the Ilium; the long Femur (F), running in line, through the extended knee-joint, with the Tibia (T); and the flexuous, mobile, vertebral column, thrown into compensatory curves. Compare Avian skeleton, Fig. 16. p. 67.

FIG. 14.—SKELETON OF MAN. (PROFILE).

form the framework of the leg proper, differ markedly in the Bird from those which form the framework of the forearm and fore-wing, and which, you remember, we called the radius and ulna. These bones, though held together by ligaments, are *complete* and capable of separation when the ligaments are cut away ; moreover they run down alongside each other *all the way to the wrist where*, making contact with some of the small wrist-bones, they help in the formation of the wrist-joint. We found that this arrangement held good in both the bird's wing and in the human arm. But the state of affairs is very different in the case of the two long bones of the bird's leg. They are called the *tibia* and *fibula*. In Man both bones are *complete* and capable of separation when the ligaments are cut away ; moreover they run down alongside each other *all the way to the ankle where*, making contact directly with one of the ankle-bones and indirectly with others, they help in the formation of the well-developed human ankle-joint. Here then you can see at once that in Man the tibia and fibula correspond strikingly to the ulna and radius. There is however one minor difference to which we must draw attention. Both the radius and the ulna make contact with the lower end of the humerus at the elbow-joint ; only the tibia makes contact with the lower end of the femur at the knee-joint. However at the knee-joint the fibula is bound securely to the tibia by strong ligaments. Look carefully at the fibula on the bird's skeleton : Some of you may exclaim, "where is it?" I can readily excuse you for not seeing it at once. (Figs. 14, 16. t., fb., Fig. 15. e., f.)

THE BIRD'S FIBULA RESEMBLES A SPLINT.

Observe ; it is that very much reduced slender, splint-like bone, tapering to a needle-point and lying in close contact,

A Weird Ancestor. R.



ARCHÆOPTERYX, THE FOSSIL BIRD.

I am here reminded of an extremely interesting matter, namely, the origin of birds traceable from a curious ancestor in which many reptilian characters are discernible... a creature, named *Archæopteryx*, which possessed wings, a pointed beak like jaw, armed with teeth... the feathers of the tail arose in pairs at different levels from successive pairs of tail vertebra."

in fact partly fusing with, the outer side of the tibia ! Note also that this curious-looking fibula *fails to reach the ankle*, indeed it is on an average only two-thirds the length of the tibia. There are rare exceptions, as the Penguin, in which the fibula reaches right down to the ankle. But it is most interesting to observe that this dwarfed fibula, in addition to the tibia,

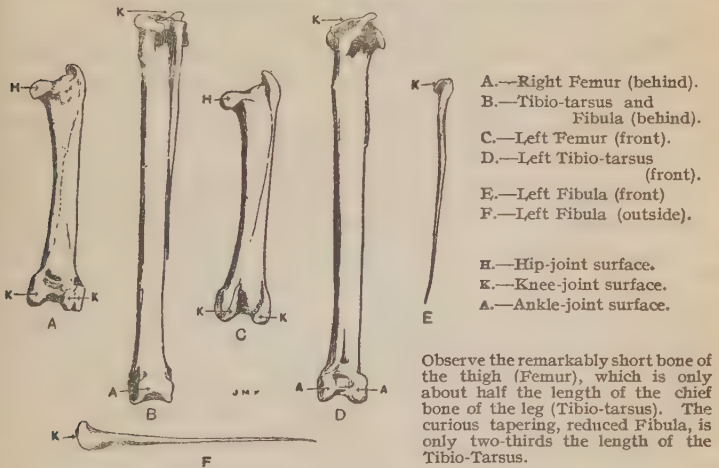


FIG. 15.—THE BONES OF THE THIGH AND LEG,
 (Femur, Tibio-Tarsus, and Fibula.)

is connected with the femur at the knee-joint ; remember again, in the human knee-joint the tibia only makes contact with the femur. Let us proceed with our studies without delay ; a delightful surprise awaits us shewing some wonderful differences which have come about in the arrangement of the bony framework of the ankle and foot in Man and Bird. Man's ankle and foot-bones follow very closely the plan of his wrist and hand-bones. We have noted that in the wrist there are eight small bones called carpals which are situated

between the lower end of the radius and ulna above and the five hand-bones, called metacarpals, below. Succeeding the bones of the hand there are the bones of the five fingers (calling the thumb a finger !), or digits. Each digit contains three bones called *phalanges*, except the thumb, which contains two. We made a count and found that the wrist and hand, when taken together, contained twenty-seven bones.

THE TARSALS, METATARSALS, AND PHALANGES.

How many bones are found in the human ankle ? Seven. We call them *tarsals*. How many bones are connected with them above ? Two—the tibia and fibula. How many foot-bones succeed the ankle-bones further down ? Five. We call them *metatarsals*. How many toes or digits follow the metatarsals ? Five. How many bones are present in each digit or toe ? Three, except in the big toe, in which there are two—we call them *phalanges*. Evidently then the thumb and big toe in regard to their bony framework correspond. Do you know any animals in which the toes, and especially the big toes, are freely movable ? Yes ; monkeys. These agile fellows can grasp the branches of trees firmly with hands and feet. Let us count the bones in the human ankle and foot. Seven tarsal or ankle-bones ; five metatarsal or foot-bones ; and fourteen digital or toe-bones (phalanges). Twenty-six in all. Observe carefully the close correspondence in number with the bones of the wrist and hand. (Fig. 14, tr., mt., ph. Figs. 11, 17.)

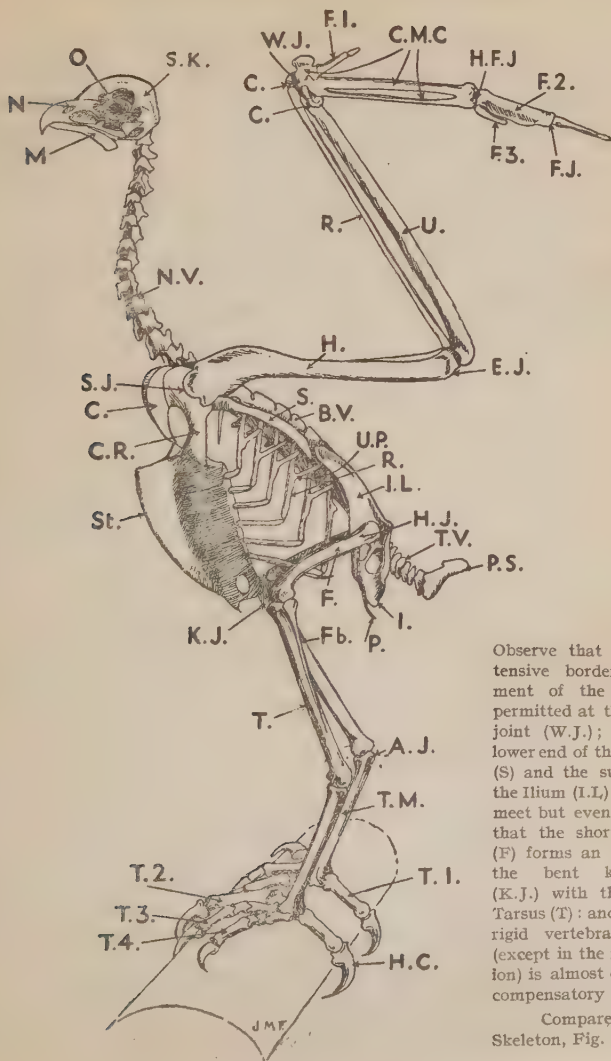
Tabulated.

Wrist and hand, including fingers : 27.

Plus lower end of radius and ulna.

Ankle and foot, including toes : 26.

Plus lower end of tibia and fibula.



Observe that very extensive border-movement of the hand is permitted at the wrist-joint (W.J.); that the lower end of the Scapula (S) and the summit of the Ilium (I.L.) not only meet but even overlap; that the short Femur (F) forms an angle at the bent knee-joint (K.J.) with the Tibio-Tarsus (T); and that the rigid vertebral column (except in the neck region) is almost devoid of compensatory curves.

Compare Human Skeleton, Fig. 14, p. 63.

FIG. 16.—SKELETON OF HAWK. (PROFILE).

Lettered as in Fig. 6, p. 31.

THE BONES IN THE BIRD'S FOOT.

Now turn to the skeleton of the bird and examine the framework of the ankle. What bones enter into its formation? The fibula has been put out of court; its stunted growth

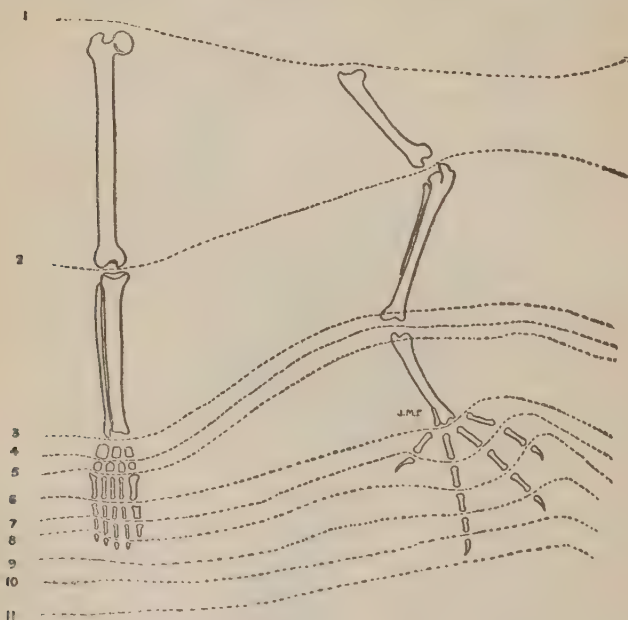


FIG. 17.—THE BONES OF THE HIND-LIMB IN MAN AND BIRD.

The broken lines demarcate the corresponding limb-segments.

Observe, in Man, line 3 passes between the lower ends of the tibia and fibula, and the upper row of tarsals (three in number). In the Bird this line passes through the lower end of the tibio-tarsus, in which is incorporated the upper row of tarsal bones.

In Man, line 4 passes between two rows of tarsal bones, (three and four in number). In the Bird this line encounters no free tarsal bones.

In Man, line 5 passes between the lower row of free tarsals (four in number), and the five free metatarsals. In the Bird this line passes through the upper end of the single elongated tarso-metatarsal bone, in which is incorporated the lower row of tarsal bones. Lines 9 and 10 in the Bird pass between bones on the third and fourth toes which are not represented in Man.

has prevented it reaching far enough down. Hence, the lower end of the tibia *alone* remains to make contact with the bones of the ankle. But no small tarsal-bones are to be seen! They have completely vanished as separate entities. (Figs. 16, 17.) What has taken place? Before the chick is hatched, several tarsal-bones can be made out, but every one disappears before the baby-bird cracks its shell and comes into the world. What then becomes of these tarsal-bones? Some fuse completely with the lower end of the tibia; hence the name *tibio-tarsus*, strictly speaking, has been adopted! Others fuse completely with the metatarsal or bone of the foot. Hence the strict name, *tarso-metatarsus*! Every single one of the little ankle-bones as separate entities has completely vanished, and surely for the bird's benefit. We shall see why presently. In the meanwhile let us note that of the five foot-bones, i.e., metatarsals with their corresponding series of toe-bones which represent the full complement present in vertebrate animals and which persist in the foot of Man, the fifth has in the Bird completely disappeared. Now in the avian hand, the fourth and fifth metacarpals and their corresponding series of finger-bones have disappeared, nevertheless the first, second, and third metacarpals and their finger-bones have persisted, although we must remember that the second and third metacarpals are united firmly at either end. The first is also united at its upper end, but free at the opposite extremity. But in the avian foot-bones, i.e., the metatarsals (quite apart from the bones of the toes), fusion has proceeded further than in the case of the metacarpals, for we find *only one metatarsal is present*. This in the living bird is usually of considerable length, covered with scales, and forms the bony framework of that region of the hind-limb *vulgarly and erroneously called the 'leg.'* No less

than four metatarsals therefore have become blended into one bone. There is just a little technical point to bear in mind, namely, that the first metatarsal is exceedingly short and juts out like a bony wart at an angle from the lower end of the main bone. It comes off at an angle in order to be in line with the bones of the hind-toe. This metatarsal of the hind-toe is not usually a separate entity; moreover when not quite fused it makes very close contact with the main bone without the intervention of a joint. Apart from the wart-like stump, which we have been examining, you cannot fail to notice at the lower end of this remarkable metatarsal, three short but distinct projecting surfaces which make contact with the nearest phalanges or series of the bones of the second third and fourth toes. The persistence of the three processes tells us that three bones have become blended into one, except at their lowest points. (Fig. 16, tm., Fig. 18, 1, 2, tj.)

Consider again for one moment the fingers in a bird's wing. Two, namely, the fourth and fifth, have completely disappeared. The first or thumb, as in the human hand, has two bones (phalanges), but they are exceedingly short, small, and often fused. True, the thumb possesses independent movement, but this is very limited. The second or fore-finger is much the longest, in fact the only long finger of the bird's hand. It has three bones (phalanges) like our own, but on account of being attached to the very short third finger, which has only one bone (phalanx), independent movement is therefore prevented. (Figs. 16, 11.)

THE TOES.

Next let us examine the toes. What a striking contrast presents itself! One, we note has certainly disappeared, namely, the fifth, (which corresponds to our little toe), but

in the more typical foot of the higher avian orders the four other toes are well-developed and enjoy a wide range of movement. To-and-fro or hinge-action is chiefly permitted at the numerous little joints, but in some birds (notably the Osprey, a large fishing-hawk), the hind-toe can be freely

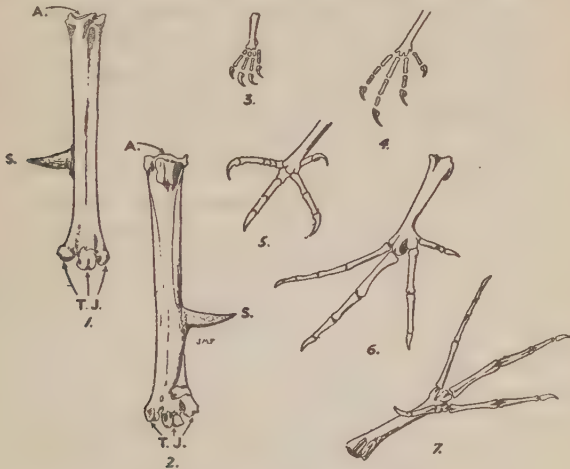


FIG. 18.—THE BONES OF THE FOOT.

(Tarso-Metatarsals and Phalanges).

1.—Left tarso-metatarsal of a fowl, (front). 2.—The same, (back). A.—Upper end which meets the tibio-tarsus at the ankle-joint. T.J.—Lower end, which meets the nearest phalanges at the toe-joints, and shews three projections which indicate the fusion of the second, third and fourth metatarsals (foot bones). In 2, the bony triangular wart-like process, representing the fused first metatarsal (foot bone) is seen immediately above the projection on the right, and below the spur (S). 5.—Right foot of Hawk. 6 and 7.—Right foot of Wild-Duck. The numbers of the phalanges are typical: two in the first or hind-toe, three in the second, four in the third, five in the fourth. In the foot of the Nightjar, 4, the fourth toe has only four phalanges and is therefore not typical. In the foot of the Swift, 3, no toe contains more than three phalanges. In this interesting departure from the type we see that the number of phalanges in the four toes correspond exactly to those in four of the toes of Man.

rotated. Count carefully the bones of the toes (phalanges). Hind-toe, two, corresponding to the number in our great-toe, and to the number in our thumb and in the thumb of the Bird. The great-toe in Man and the hind-toe in the Bird therefore

exactly correspond to one another, and also in turn to the thumb in Man and Bird. The second toe has three bones (phalanges), corresponding to the number in our second toe, and to the number in our second finger and that of the Bird, it being understood that we are regarding the thumb as the first finger. The third toe has four bones (phalanges). Here we see clearly that the bones in the Bird's toes, taken collectively, are steadily increasing in number! The third toe possesses one bone (phalanx) more than is found in our third toe or in our third finger, while it has three bones more than are found in the avian third finger. Go on with your count, my young friends! Matters are getting exciting! The fourth toe has five bones (phalanges), two more than are present in our fourth toe or fourth finger. The Bird has no fourth finger, neither has it a fifth toe nor finger. We have three bones (phalanges) in our fifth or little toe and finger respectively. Now here is a striking point: add up and you will find that the four toes of a bird taken collectively, furnish as many bones as the five toes or fingers of a man! The number being fourteen. The ratio therefore of the number of bones in the toes of Bird is higher than in Man. In the case of the number of bones in the fingers of Bird compared with those of Man the ratio is reversed. Thus: the number of bones taken collectively in the thumb, second, and third, fingers in Bird total six; in Man, eight. (Fig. 16, t1., t2., t3., t4. Fig. 17, Fig. 18, 5, 6, 7.)

FREEDOM OF TOES IN BIRDS.

Man and Bird then have freely movable jointed toes. But the latter, generally speaking, can claim greater range of movement to enable it to clasp the branches of trees securely both when awake and asleep; also in the case of birds of prey to

snatch up the victim in an instant ; in the case of fowls to scratch the ground in searching for food, and in the case of parrots to hold the food and bring it to the mouth. The toes can operate in many other directions, as in climbing, clinging, and swift locomotions on land and water. But in the case of the front-limb, while Man has freely movable jointed fingers, which are necessary to enable him to carry out the exquisitely varied, highly skilled, and often delicate work, no less than to grasp and carry heavy objects, also to convey food to his mouth and do very many other things, the Bird on the contrary has fingers united and deprived of free movement individually. This arrangement, as already pointed out, is necessary to give maximum strength to the feathered hand when it cuts through the air like a flail. Count the bones in the *foot* of the bird. How many ? One ! Yes ; only one ; the *tarso-metatarsal*, that characteristic long bone, already carefully described. Count the small (tarsal) bones in the *ankle*. How many ? None ! Yes ; not one ! Remember some have merged into the tibia or 'leg bone,' others into the metatarsal or single foot-bone. A much modified joint therefore is formed between the ends of the single long leg-bone and the single long foot-bone. *Two bones* only form this joint, but they are usually long, and therefore plenty of leverage is obtainable during movement. (Fig. 16, t., tm. Fig. 17.)

ANKLE-JOINT IN THE BIRD A PURE HINGE.

What movement then is permitted at this joint ? Absolutely none other than to-and-fro or hinge-movement. When the hinge is fully opened the two bones are brought into line ; when closed the two bones meet. We observe that when a bird perches on a twig, and sharply bends this simplified ankle-joint (that is to say closes the hinge for the most part)

the toes immediately encircle and tightly grip the support. At the same time the centre of gravity is adjusted by the weight of the body bending the thigh forwards at the hip-joint and the leg backwards at the knee-joint in conjunction with another forward bend, namely, of the foot at the ankle-joint. I feel sure you will understand how it is that the complete absence of the free little bones at the ankle-joint is to the bird's great advantage. If they were present they would tend to weaken the *pure* hinge-movement by introducing lateral or side-movement. A bird when running or bouncing along, brings its toes only in contact with the ground. The heel of the ankle-joint is carried away high up at the top of the long very slender *scale-covered foot*. Consequently there is no need for that special spring or elasticity in the ankle-joint which is coupled with side and even some rolling movement. On the other hand, a large degree of elasticity is quite necessary when we walk, because at each step we have to lift the entire *heel* off the ground and transmit the weight of the body obliquely along the sole of the foot inwards towards the great toe. Just take a step or two forwards: you cannot fail to notice that the movement at the ankle-joint is not confined purely to the hinge-type. In fact you can rotate your ankle sufficiently to allow your body to support itself on the outer edges of the foot.

THE ANKLE AND THE ORANGE-PEEL.

When our foot slips on an orange-peel we may *turn our ankle*. No doubt an unpleasant mishap, but at the same time let us make the best of it by noting that an instructive demonstration is here afforded of the considerable range of lateral movement permitted at this joint. Many highly skilled and graceful gymnastic exercises which we can perform, depend

upon various free movements at the ankle-joint. Dancing and skating, with their exquisitely fine elaborations, could never have reached such a pitch of perfection were the human foot deprived of its separate and movable tarsal and metatarsal bones and their numerous intervening joints. Many small birds are swift and nimble on foot ; they trip along in a most dainty, elegant manner, delightful to behold. Birds when courting are also very agile, and start bouncing up and down, now to the right, now to the left, now in a circle,—really, a most amusing spectacle ! In these performances the ankle-joint acts purely after the fashion of a hinge ; only to-and-fro movements being permitted. Alas ! no ; our dear little feathered friends, though æsthetic and gifted in many directions, cannot dance in the true sense of the word. The *dancing bones* are wanting in their ankle-joints !

Such then has been our survey of the bony framework of the bird's hind-limb, mainly from the technical standpoint. In the next chapter some interesting features in regard to the hind-limb in action will be considered from the general rather than from the special outlook.

CHAPTER VI.

THE HIND-LIMBS IN ACTION.

Skeleton of a horse added to our equipment—Avian hind-toe and human great-toe—Variations in feet and arrangement in toes in different classes of birds—Grasping powers—Hand-like feet—Diminution and disappearance of hind-toe—Characters of the feet in wading and swimming-birds—Grasping faculty absent—Identification of the regions of the hind-limb by sense of touch in Herring-Gull—Comparison of hind-limb in plucked duck with that in Man—Feet and toes visible only in living bird—Typical foot, long, thin, scale-coated—‘Dicky,’ my pet canary—The direction of the axes of the different regions of the hind-limb—The Gannet’s ‘Hobble’ skirt—The axis of the hind-limb in Man compared with that in Bird when standing—Bird’s rigid back—Its centre of gravity when standing—Reasons why Man can and Bird cannot assume the perfectly erect posture—Flexuous character of human vertebral column—Compensatory curves—Centre of gravity finely adjustable—A story of a school-boy’s anatomical discovery—The bony framework of the limbs in the Horse. Comparison with same in Man and Bird—Fundamental correspondence—Secondary differences—The extremely specialised feet and hands of the Horse—Trotting on the tips of fused and enlarged nails of the fingers and toes—Hoofs.

EXCELLENT news! We have just been given, by very kind Mr. Naturalist, a splendid skeleton of a horse. This gift will be really very useful later on, when we wish to compare collectively the hind-limb of the bird, our hind-limb, and those of other animals.

We have still several interesting points in connection with the avian hind-limb to follow up, which may be viewed chiefly from the general standpoint. Technical matters are bound here and there to crop up in this chapter, but as we are already familiar with most of them, they will help rather than overload our studies of the main issue, namely, the

hind-limbs when in action. We shall see presently that the particular use to which a bird puts its hind-limbs is closely correlated with its habits. In some species toes can function, in a large measure, as fingers; in others they remain toes which cannot clasp. Great varieties are presented in the form of the feet and toes in different classes of birds. In association with these facts we shall be able to look into the question of relative speed and endurance maintained by the action of the hind-limbs. Another point of surpassing general interest concerns the maintenance of the centre of gravity when standing or walking compared with the same in Man, seeing that both creatures are bipeds, that is to say they do not use the front-limbs for the purposes of locomotion.

THE HIND-TOE.

Let us begin our studies with a reference again to the hind-toe. We have already learned that it corresponds to our big toe. We have observed that in each there are two bones. In other words each possesses two phalanges. This is a reliable method of identification. Indeed it is a test which could be applied were the bird's toe cut off and placed for identification on the table. Note carefully that our big toes face each other and lie along the inner margin of either foot. On careful inspection we discover that the hind-toe of the bird also springs from the inner side of the foot and faces its fellow on the opposite foot. Again, we are able to make out that it is really the first toe of the bird (shall we call it the 'big' toe for the moment?), that has migrated round to the back of the foot. In some birds the fourth toe has also migrated and taken up a similar position: we find this arrangement in the foot of the Cuckoo, in that of the Woodpecker, and notably in that of the Parrot. The

last-named when eating, (which it usually does in a rather slow, deliberate manner), holds its food in one foot. We would make use of our hand for a similar purpose. (Fig. 19, G.)

THE FOOT OF THE SWIFT.

It is more uncommon to find all four toes directed forwards. The well-known and abundant Swift has very short stout, feet, with the toes thus disposed. The claws are thick, strong and curved, and the feet are used essentially for clinging purposes. The Swift never perches on the branches of trees nor alights on the ground or other plane surfaces. (Fig. 19, C.)

In our familiar garden-birds which perch on trees, also in birds-of-prey, all four toes are well-developed, freely moveable, and can be separated far apart when extended and then brought close together when fully bent, according to the girth of the object which is clasped. (Fig. 19, E., F.) The main strength lies in the firm grasping powers of the toes, exercised *intermittently*, when the bird seizes hold of its prey, or when it flits from tree to tree in search of food; or *continuously*, when it sleeps upon its perch. We speak of a sparrow hopping about, we mean strictly speaking, jumping, or we might more conveniently adopt the expression '*bouncing*.' "Let's pretend" that a certain House-Sparrow understands our language. What would be his answer when asked to bounce along the road for half a mile without once lifting his wings? Ah, well; replies our little friend, "I shall try, but I doubt if I could accomplish the journey without an occasional stop—if I did succeed I should certainly reach the goal in an exhausted state." Yes; even a starling, which marches about in a sprightly and nimble fashion, would find a walk of half a mile irksome, unless occasionally he rested his leg-muscles when he raised his wings and made short flying darts over the ground.

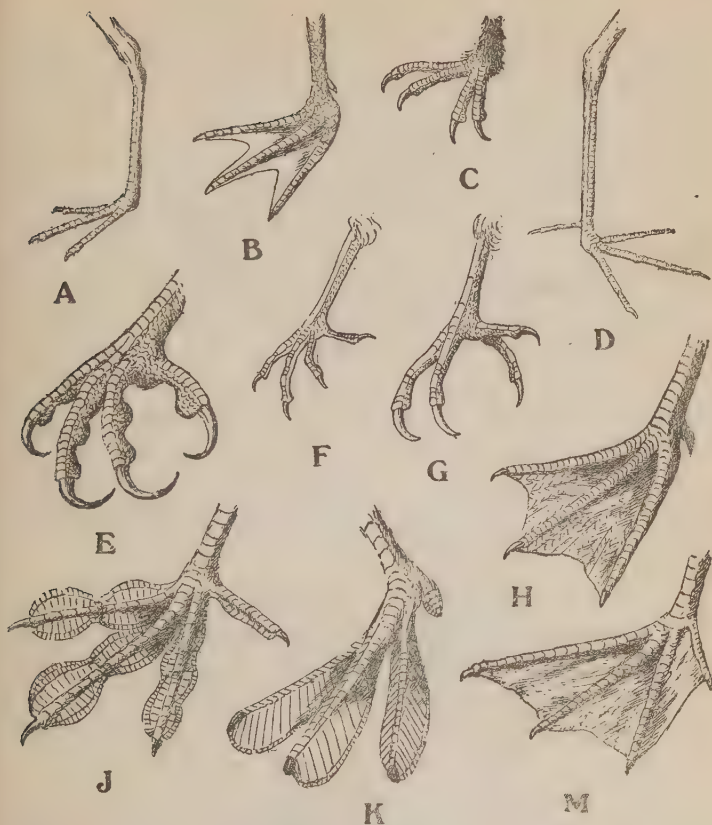


FIG. 19.—VARIOUS TYPES OF FEET.

A.—Sanderling, (hind-toe absent). B.—Avocet, (hind-toe minute). D.—Godwit, (hind-toe small and raised above the ground). In these shore-birds the grasping power of the toes is lost. The feet are used purely for locomoting on level ground. J.—Coot, (web divided and lobed). K.—Grebe, (web divided and leaf-shaped). H.—Duck, (web entire, uniting the front toes). M.—Cormorant, (web entire, uniting all four toes). Here again in these aquatic birds the grasping power of the toes is not permitted. E.—Hawk. F.—Thrush. G.—Woodpecker. All toes free, very moveable, well developed, and capable of strong grasping powers. Observe in the Woodpecker the fourth toe has migrated backwards, facilitating climbing purposes. C.—Foot of Swift. All four toes directed forwards. Claws robust, sharp, and essentially adapted for clinging purposes.

THE FEET USED AS HANDS.

What then is the general principle underlying these interesting observations? It is this: that the feet of perching-birds function much more as hands, in virtue of their strong clasping-powers, than as organs for locomoting on the ground. But bear this point carefully in mind: unlike the human hand the avian toes have little or no independent movement: when one opens and spreads apart, the others follow suit. When one attempts to close upon and clasp the twig of the tree, the others likewise partake of the action. Perching-birds therefore cannot make use of their toes for skilled movements, which are however carried out by that neat little instrument, the beak, indeed in some directions in really quite a surprising manner, notably in nest-architecture. Have I not in the opening chapter told you many interesting things about the beak? You recollect I have already called it the *Jack-of-all-Trades* implement!

THE FEET OF WADING-BIRDS.

Some birds, for instance, plovers, sandpipers, and others, frequenting marshes and sand-flats, and generally known as *waders*, have not the power of clasping branches, and cannot be said to perch in the true sense, though exceptionally they may alight on trees. On the level ground wading-birds distinguish themselves by the rapid rate at which they can race hither and thither with unflagging energy. Observe, the hind-toe is very small; in some species it has almost reached the vanishing point; in others it has completely gone! When present, it is set on the foot at a slightly higher level than the front-toes; consequently, when the bird is walking, the hind-toe is always raised above the ground and manifestly plays no part in the act of progression. All the same,

we observe here a very efficient foot, in which the toes are purely used for purposes of locomotion ; hence clasping, after the fashion of a hand, is ruled out of court. (Fig. 19, A.B.D.)

WEBBED FEET.

We can now remove the feet of our Herring-Gull from the bowl of water in which they have been soaking. We notice how nice and pliable the joints have become, and also that the webs have lost their puckered shrivelled state. Observe carefully that the webbing is attached to the front-toes : the hind-toe is free, raised at a slightly higher level on the foot, and quite minute. (Fig. 19, H.)

Several species of aquatic birds move on land with an awkward, shuffling gait. Who is not very familiar with the deportment of a duck when it waddles along the roadside ? Aquatic birds, in which all four toes are connected by webbing, on leaving the water usually stand motionless on a rock or other support, because their power of locomotion on dry-land is so impaired. Furthermore, they cannot support themselves for long upon their toes, consequently the whole length of the foot, including the heel, needs make contact with the ground. (Fig. 19, M.) There are several other variations in the feet of birds which here would take us too far afield to describe. (Fig. 19, J. K.)

THE HIND-LIMB OF OUR HERRING-GULL.

I am very anxious that you should examine in our Herring-Gull, the hind-limb, as it lies in position partly hidden in the plumage. I also want you to examine the hind-limb in our Duck, *plucked naked*, in order that in both specimens you may fully understand in what way they correspond with our hind-limb. Your observations, already made on the skeletons of Man and Bird, will render this task exceedingly

light and interesting. By this time you will have learned that the bones correspond, due allowance being made for fusion of some and absence of others. No doubt you have also grasped a very interesting fact, namely, that although the individual bones of the hind-limb and front-limb have received different names, they also form a corresponding series. It is a matter of no moment which two limbs we select for comparison. Whether we compare the bones of our own leg with those of our own arm, or with those of the avian wing or leg ; or begin by comparing the leg-bones of the latter with those of the wing or with those of our arm or leg ; group your comparative studies as you prefer, and still the bones will be found to form a most interesting corresponding series. Let me briefly summarise : you have become familiar with the fact that in each of these limbs there is one bone in the upper part, namely the humerus in the arm, and the femur in the thigh ; then a hinge-joint, elbow or knee ; then two long bones, radius and ulna in arm ; tibia and fibula in leg ; then a joint, wrist or ankle, connected with small bones carpal or tarsal ; lastly hand-bones, and foot-bones, metacarpals and metatarsals, followed by finger-bones and toe-bones, called phalanges or bones of the digits. We have noted one exception, however, namely, that avian tarsals, as independent entities, are absent.

THE FOOT AND TOES ONLY VISIBLE.

Viewing our Herring-Gull as it lies breast towards us on the table, tell me what parts of the hind-limb are visible ? Only the foot and toes ; in other words those parts of the limb devoid of feathers, though clothed with scales. Let me explain. Remember that with few exceptions a bird stands, walks, runs, or bounces, on its toes, as we sometimes do when we raise our heels and move on ' tip-toe.' The foot,

apart from its toes, is as a rule long and thin, hence the heel is carried high off the ground so that the ankle reaches to the level of the feathers clothing the under surface of the abdomen. Likewise, in perching birds, we see that it is only the toes which clasp the twig. Look at your pet canary, swaying so gracefully on his perch during his outburst of melody! Are you correct in saying to me, "I am very glad that you admire Dicky's slender and elegant ivory-tinted legs and feet?" No, no; say his feet and toes, if you please! Pull down the foot of the Herring-Gull and the lower part of the 'leg' will come into view; then it may be seen that the scales, extending a little way above the ankle, clothe the lowest part of the leg.

EXAMINATION OF THE LEG AND THIGH BY THE SENSE OF TOUCH.

The rest of the examination must now be conducted by the sense of touch. Pass the fingers through the feathers up along the course of the leg: you will soon appreciate the increasing thickness (due to the presence of several powerful muscles), and considerable length of this part of the limb, as the fingers wander up to the knee-joint. The forward bend of this joint now becomes very evident. Remember that knee-joints always bend forward and straighten out backward. See this when you bend your own knee! We can feel that the knee-joint in our Gull is situated very high up, abutting right against the body-wall. Beyond the knee you will feel the short thigh, which, as it passes backwards to the hip-joint (in a direction towards the tail), is quite closely applied along its whole length to the side of the body. This is the moment to determine three nice points by the sense of touch. Firstly, that the long axis of the leg towards the knee is directed *forwards* or towards the head; secondly,

that the knee is sharply bent forwards ; thirdly, that the long axis of the thigh from the knee is directed *backwards* towards the tail. As the thigh is thick and short and abuts against the body-wall in its entire length, it is well to grasp it between your finger and thumb and then endeavour to separate it from the body-wall, as far as the skin covering it will permit. It would be much easier to follow the contour of the limb by the sense of touch if the skin were folded neatly and closely round it : *in other words if the thigh were trousered by the skin.* But in birds, with very few exceptions, the hind-limb, unlike our own, is not separated off from the body by a fold of skin the whole way from the hip downwards. In most birds, the thigh is enclosed almost in its entire length within the general skin-covering of the body ; (Fig.20.C.D.) moreover, this inclusion may extend much lower down the leg, reaching in the case of some water-birds (for instance the Grebe and the Gannet), almost to the ankle-joint. (Fig.20.A.B.)

THE GANNET'S ' HOBBLE SKIRT.'

That is the reason why the Gannet and several other species of diving-birds walk so awkwardly on dry-land. We may aptly compare the manner in which the skin of the bird's body is related to the hind-limbs to a lady's skirt which, if it extends almost to the ankles and is at the same time too tightly fitting, must interfere with walking and much more so with running, where the strides taken are three or four times the length. The Grebe or Gannet is much more unfortunate than the lady in this respect, for it can neither shorten nor liberalise the girth of its 'hobble' skirt, if such an alteration were permitted in accordance with the dictates of fashion ! Alas ! the poor bird is destined to move on dry-land with little more aptitude than one of us would display when trying to run a race in a sack ! (Fig.20.A.B.)

FIG. 20.—THE GANNET'S 'HOBBLE SKIRT' AND THE ROOK'S 'APRON.'



A.—GANNET



B.—GANNET

A. and B.—Newly-hatched Gannets. The thighs and legs are enclosed in the general skin-covering of the body-wall. The feet, even when spread widely apart, (A) alone are visible. The lower limbs, except the feet, are, as it were, swathed in a 'hobble skirt.' Consequently, progression on land is laboured and awkward. In the Grebe, Cormorant, and several other species of aquatic birds, the same features are presented.



C.—ROOK



D.—ROOK

C. and D.—Mature rooks, completely denuded of their plumage. The short, thick, thighs are enclosed within the general skin-covering of the body-wall. Even when the lower limb is widely spread out from the body, (D), the contour of the thigh cannot be defined. The thighs are, as it were, flanked by an 'apron.' In birds the thigh is not 'trousered' by the skin. Therefore, to see the knee-joint it is necessary to split up the skin and turn it aside. "By such a procedure the thigh is set free entirely from the side of the body-wall."

Now turn your attention to our Duck as it lies plucked upon the table. Support it on one side and we shall have no difficulty in seeing at once that the different regions of the hind-limb exactly correspond to those in our limb. The lower region,—*you know it is called the leg proper*,—which thickens rapidly when traced from the ankle to the knee, is very distinct; but we see the knee-joint itself and the short thigh much clearer if we slit up the skin covering those regions and turn it aside. By such a procedure the thigh is set free entirely from the side of the body-wall. If we separate for a little distance both the wing and leg (*leg here meaning whole hind-limb*) from the side of the body, we then see that, in general form and position, the former more closely resembles the human arm than the latter resembles the human leg (again the term *leg* signifies the entire hind-limb). This is due to the fact that the upper region of the wing is nearly as long proportionately as the upper region of our arm ('arm' of the anatomist), and occupies the same position relatively to the side of the body. On the contrary the thigh in the Bird is much shorter than in Man and occupies quite a different position relatively to the body. When a bird spreads its wing or when we spread our arm, the elbow in each case is carried well away from the body-wall: on the contrary when a bird stands or locomotes on the ground, its thigh (always bent at an angle with the hip-joint), together with the knee-joint (also bent), remain in close proximity to the body-wall. (Fig. 16, f., kj.) When you and I stand or walk, our thigh and knee-joint are situated far below our body-wall, indeed our knee-joint is quite remote from it. (Fig. 14, f.)

RESEMBLANCE BETWEEN NAKED WING AND ARM.

The naked wing, therefore, despite the fact that the framework of the hand has been highly specialised for the function

of flight, more closely resembles the human arm than the avian leg resembles the human leg in their proportions and positions relative to the body ; yet in the case of the leg both serve the *same function*, namely, locomotion. Now this contrast between the human and avian leg, relative to the position of the body, is highly interesting seeing that neither Bird nor Man bring their front-limb into contact with the ground when locomoting. For convenience sake we speak of animals which walk on all fours as *quadrupeds*, meaning animals with four feet ; we shall see presently, when our skeleton of the horse has been examined, that in the so-called front-legs the bones and joints correspond to those of our arm and of the bird's wing. Strictly speaking, a horse has only two legs, for the term leg must be used anatomically in connection with the hind-limb, in which we shall expect to find the bones and joints corresponding to those in the hind-limbs of Bird and Man. In the meantime, observe again that a bird is not a quadruped, but like you and me, a *biped* or two-footed creature. We carry ourselves in a perfectly erect attitude (*or we ought to do so*) ; the carriage of most birds is semi-erect ; in some species, notably puffins, penguins, and many other diving birds, it is quite erect.

ERECT POSTURE IN BIRDS

Nevertheless, smart little Mr. Puffin, upright in deportment, cannot straighten out his thigh sufficiently to bring it in line with the long axis of his body. Indeed when he seems to stand fully erect, with his whole foot, including his heel, placed on the ground, he is, according to the relative position of his hind-limbs to his body, *squatting*. Moreover, when he raises himself on 'tip-toe' and brings his whole foot in a vertical line with the lower segment of his leg by

straightening out his ankle, he still cannot bring his thigh in line ; it always makes an angle with the rest of the limb at the bent knee-joint as well as at the hip-joint. We ask why should this be the case ? Because the bony framework of the back is so rigid and the immense breast-bone with its keel (heavily weighted by colossal breast-muscles) is placed so far in front of the hip-joints, that it would be impossible for the bird to adjust its centre of gravity in order that it may fall within the limits of the area of support. Surely it is obvious that poor Mr. Puffin would topple forwards ! The thigh therefore must make an angle at the hip and knee.

ERECT POSTURE IN MAN.

How is it possible for us to stand so perfectly erect that the long axis of our thigh and leg run in a line with the long axis of our body ; in other words the thigh is not set at an angle with the hip and the knee ? Because, in the first place the front of our body presents a flattened contour, and hence is not proportionately so heavily weighted ; our breast-bone and breast-muscles do not project forwards in the form of a massive keel ; moreover they are decidedly insignificant in size and weight when compared with the same in the bird. Then again our back-bone is not by any means rigid ; far from this being the case, it is on the whole very flexuous, so that the power we have of throwing different regions of it into opposite (or what we call compensatory) curves, permits of much latitude in regulating the centre of gravity in order that it may fall within the area of support. Take a glance at the vertebral column in the human skeleton : observe that the neck-region curves forwards, the region related to the ribs curves backwards, the region below the ribs curves forwards again, whilst the lowest region (where nine vertebræ fuse to form the sacrum

and coccyx), again curves backwards. (Fig. 14, nv., bv., sa., cx.)

In assuming the erect attitude, our front-limbs have been set at liberty and can therefore perform very varied and highly skilled movements. Our intellectual development depends largely on the fact that we are not called upon to use our front-limbs for purposes of locomotion in conjunction with our hind-limbs.

BALANCE OF THE HUMAN BODY.

Has the balance of our body become less secure in being supported on only two limbs? No; it is indeed otherwise. Our body has adapted itself perfectly to the erect posture. With only two limbs for locomotion, we can walk, run, hop, skip, jump, dance, and skate.

Some movements which we can perform are exquisitely fine, airy, and graceful, as seen for instance in dancing; others are really marvellous and daring feats in gymnastics. It may seem at times astonishing that we do not often topple over. Surely our centre of gravity must be capable of the finest adjustment! The mechanism of the movements of the human hind-limb, and more especially of the foot, with its arched instep so full of elasticity and spring, leaves bird and beast far, far away behind in that respect.

We have now completed our survey of the limbs of birds. We have dealt with the anatomy of the bony framework, but as we went along we were able to introduce many other points of interest. Our comparative studies have led us to conclude that both front and hind-limbs are built upon the same general plan, which indeed is characteristic of the limbs of all vertebrate animals. We noticed, however, certain startling modifications which must be associated with the particular purposes to which the limbs are subjected.

THE STORY OF A SCHOOL-BOY'S ANATOMICAL DISCOVERY.

But our lesson would be incomplete if we closed this chapter without taking a glance at the limb-bones of a quadruped, that is to say an animal which in walking puts all four limbs on the ground. Let me first tell you a story : A good many



FIG. 21.—THE WRIST AND ANKLE OF THE HORSE.

"See! he exclaimed;....This horse has elbows on its hind-legs, and knees on its front-legs!"

years ago I knew a school-boy whose age at the time was about thirteen or fourteen. He seemed to have been born with a great love for animals, and not only incessantly watched their habits, but also had a passionate desire to probe into

mysteries regarding the structure and machinery of their bodies. So one fine day he collected a group of school-mates around him and asked them to follow him into a field and to look at a horse, concerning the limbs of which he would tell them an interesting thing he had discovered. See! he exclaimed; how a four-footed animal differs from a man! This horse has elbows on its hind-legs, and knees on its front-legs! It was far better for that impetuous boy to have made this observation, and, to the best of his belief at the time, to have thought that he had solved an important problem in zoology, than to have passed by without noticing the horse. Because many years afterwards when he found out his mistake, it was a matter of profound interest for him to learn that those joints which he had imagined to have been elbow and knee were in reality ankle and wrist. That school-boy of other days, invites you to determine, on the skeleton of the horse, how definitely the limbs correspond with those of Bird and Man!

THE LIMB-BONES OF MAN AND HORSE.

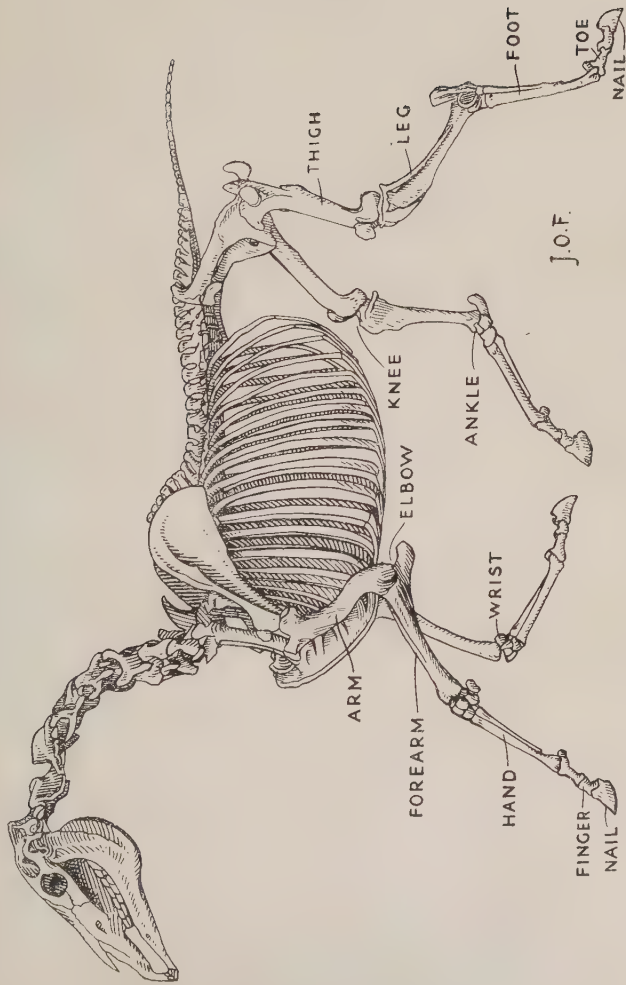
Observe in the hind-limb the knee-joint bent forward but *very high up*, and abutting against the body, because of the marked shortness of the femur, which in turn is bent at an angle at the hip-joint. See the tibia and fibula, the latter, like that of the bird, resembling a splint. These bones enter into the formation of the knee-joint in conjunction with the lower end of the femur. In the same limb there is the ankle-joint with its prominent heel inclined backwards but situated *far off the ground*, owing to the *peculiar length of the foot*. See the lower end of the tibia, with small bones forming the framework of the ankle. Then follows the foot, *itself very long*, with only one metatarsal, and remnants of two others in the form of slender fused splints

on either side. Note the single toe (reduced to one through fusion), with its three bones (phalanges), the lowest of which expands into a great nail, the hoof! This hoof alone touches the ground! Turn to the front-limb: observe the elbow-joint bent backwards, also *very high up* and abutting against the body, because of the marked shortness of the humerus, which in turn is bent at an angle at the shoulder-joint. See the ulna and radius, the former resembling a splint. These bones enter into the formation of the elbow-joint in conjunction with the lower end of the humerus. The wrist-joint, like the ankle-joint is situated *very high up from the ground, owing to the peculiar length of the hand*. See the lower end of the radius, with small bones forming the framework of the wrist. Then follows the hand, *itself very long*, with only one metacarpal, and remnants of two other splint-bones as in the foot. Lastly, note the single finger (reduced to one through fusion), with its three bones (phalanges), the lowest expanded into a great nail, the hoof. This hoof also alone touches the ground! Surely we find here that the correspondence between the bones of the upper and lower limbs is exceedingly close, in fact the bony framework of hand and foot shews a uniform pattern. (PL. v.)

THE HORSE LOCOMOTES ON HIS NAILS.

Interesting then to relate, a horse locomotes upon its united and expanded nails, which spring from the very tips of the fingers and toes. We call the nails *hoofs*. The rest of the digits are off the ground. The Bird walks by bringing the full length of his toes to the ground (barring the hind-toe in some species). Man when walking brings not only his toes but his whole foot (including his heel) to the ground. When the bony framework of the equine limbs is compared with that in Man, we note that a great reduction in the number

The Horse Locomotes on his nails.



SKELETON OF A HORSE IN WHICH THE BONES AND JOINTS OF THE LIMBS ARE NAMED, IN ORDER TO INDICATE THEIR CORRESPONDENCE WITH THOSE IN MAN.

“The wrist-joint, like the ankle-joint, is situated very high up from the ground.”

of bones of the hand and foot in the former has taken place. The numerous foot and hand-bones succeeded by numerous fingers and toes, each in turn comprised of several more bones, would serve no useful purpose to the horse when trotting over rough, stony roads. Because this quadruped makes no other use of his four limbs but to trot about, little variation has arisen between the number or arrangement of the bones of its hand and foot. Bone for bone they are very similar. They have, so to speak, surely been 'cast in the one mould.' The bony frame-work of the avian hand presents a different pattern from that of the foot: because each has very different work to perform. The bony framework of the human hand and foot, in the number and arrangement of the bones and the freedom of the digits, follows a similar pattern: nevertheless Man has lost almost entirely the power of using his toes to pick up objects, or to clasp a tree in order to give support to his body in climbing. Possibly he might have succeeded, at least partly along such lines, had he never worn boots and stockings!

LIMBS MODELLED ON SIMILAR LINES.

Now our story is completed: we have learned, I hope satisfactorily, that in Man, Horse, and Bird, the hind-limb, always called in popular language the '*leg*,' is modelled on similar lines, and that the front-limb, variously called arm, wing, front-leg, etc., is likewise similarly modelled, and that both are built on the same general plan. (Figs. 14, 16. PL. V.)

Lastly, we have learned that modifications in the size, number, and arrangements, of the individual bones are *secondary characteristics*. But after all can we speak of the front-limb of any vertebrate animal as a leg? Anatomically speaking it is not correct. What then should we call the front-limb of a horse? An arm? Seems strange! Perhaps for the present, for want of a better term, we must leave it at that.

LECTURE 4.

CHAPTER VII.

THE THREE WOOLLY BABES.

A Fairy-Narrative for the Little Ones.

Strange voices in the wood—Three woolly-coated visitors appear—We question them about their dress—Mr. Caterpillar's ill-mannered remarks—Cheery Chick Pheasant has much to relate—Baby Bunny timidly but politely gives his answer—We tell our visitors the story about their dress—Mr. Caterpillar drops off fast asleep after a horribly gluttonous meal—He next becomes shut up in a shell—The simple story of Bunny's coat—Why Mum, Dad, and Baby, dress alike—Why Chick Pheasant is first dressed in wool—Comparison between Hair and Down-feathers—Difference in structure—Chick Pheasant grows rapidly and rises from the ground in a strikingly new form of dress—A special costume which allows him to fly—The story of Mr. Caterpillar's startling changes, not only in dress but whole appearance—He alters his name and becomes Mr. Chrysalis, lastly Mr. Moth—Woolly coat serviceable to Mr. Caterpillar when creeping about unable to fly—Loses his hairs when he becomes motionless—Mr. Chrysalis, boxed up in a shell—Long hairs would obstruct movement of wings—Hairs of Mr. Caterpillar absent in Mr. Moth—Wings covered with fine powdery material—A striking change of dress—Summary—Bunny never leaves the ground and so has no need to change her dress—Chick Pheasant and Mr. Caterpillar leave the ground and take to the air, hence a change of dress necessary—Farewell, little visitors—Salutations—Home again and round the table—We examine the plumage of our Herring-Gull—Observe system of over-lapping feathers—The curvature and elasticity of a feather—Webbing, barbs, and barbules—Rotation and other movements of long wing and tail-feathers—Steering—Feather-Tracts—Primary use of all feathers.

WE have by this time overhauled our dead Herring-Gull so thoroughly that before skinning it in order to see its deeper machinery, the feathers only remain for examination. We shall see that there are surprisingly interesting points to be studied in connection with the plumage.

“ Let’s pretend ” that it is a lovely, fine, warm day in early summer, say about the middle of June, and that, after a long ramble, we find ourselves sitting down for a rest, among nice, soft, dry, mosses and ferns, in a picturesque wood. As we *chat* about various interesting plants, creatures, and other objects of Nature, our conversation is suddenly checked on hearing three *strange* voices, each very unlike, but all saying the same words, which run :—“ We are coming to show you our dress, and shall be delighted to answer questions which you may ask about it.”

STRANGE VISITORS.

The three quaint visitors already stand before us, each wearing a woolly coat. (Fig. 22).

What question shall we ask them, boys and girls ?

It must be short, and at the same time to the point. Yes ; you have really made quite a good suggestion, namely, that we should enquire if they will continue to wear their woolly coats all their lives ?

MR. CATERPILLAR, OF ‘ WONDERLAND.’

I think we had better ask our smallest visitor first, for Mr. Caterpillar is a very sensitive creature, and extremely easily offended. You remember that when Alice, during her adventures in ‘ Wonderland,’ came across Mr. Caterpillar, seated upon a mushroom smoking a hookah, she found it

was very difficult to make pleasant conversation, even when she peeped over the edge of the fungus and, in her usual, polite manner, tried to understand the remarks of her morose companion. (Fig. 23).

THE QUESTION—MR. CATERPILLAR'S RUDE REPLY.

But now let's begin conversing with our visitors.

" Good afternoon, Mr. Caterpillar. May I ask you a question ? "

" Don't ask me may you ask a question ; that is waste of time ! Ask me at once about my woolly coat : I am here to answer that question."

" Well, then, Mr. Caterpillar, please tell me if you will wear that beautiful, soft, woolly, coat all your life ? "

" Of course not ; don't take me for a silly fool ! What good will this coat be to me when I become a boxed-up chrysalis, or afterwards when a flying moth ? Long woolly hairs would be in my way when flying about. They would interfere with the movements of my wings. When I change into Mr. Moth, my body will be covered with fine powder, which, seen under the microscope, looks like a collection of thousands of tiny feathers."

" Thank you, Mr. Caterpillar."

" Don't waste time in thanking me ; be quick and put the question to my mates."

" Whisper, my young friends ; did I not say that Mr. Caterpillar is easily offended : he is a rude creature, to be sure !

CHICK PHEASANT'S FULL AND CHEERY REPLY.

" Well, Chick Pheasant, I want to ask you two questions."

" Oh, yes, please do, and more if you wish ; for I feel sure that I shall be able to answer them."

"Tell me, dear Little One, in the first place, are all baby birds clothed in a nice soft woolly coat?"

"Oh, dear me, no, only lively chicks like myself, which must run about directly they are hatched. This thick coat keeps us warm, protects us from scratches, and matches the foliage of the wood so nicely that Mr. Weasel and Mr. Sparrow-Hawk find it difficult, and often impossible, to see us, especially



J.M.F.

FIG. 22.—OUR THREE WOOLLY-COATED VISITORS.

"What question shall we ask them boys and girls?"

when we crouch low in hiding. Cousins Baby Blackcap and Robin, who remain in their nests till they have grown feathers, are, when newly-hatched, almost naked; but as they lie cuddled up together in their cosy nest, lined with

feathers and wool, they are kept warm and comfortable. In addition, they obtain heat from the body of their mother, who, in their earliest infancy, broods over them at intervals. It is true that some baby-birds, which remain in the nest and are reared by their parents, are born clothed in thick, fluffy, woolly coats, but they may be regarded rather as exceptions to the general rule. I should also like to tell you that those birds which are born naked and helpless belong mostly to the higher classes, of which your familiar garden-birds are examples. Cousins Robin, Sparrow, Thrush, and Blue-Tit, and many others are members of the higher class of birds. We Pheasants, also our good friends Grouse, Partridges and Quails, who frequent dry localities, together with wading-birds such as Plovers and Sandpipers, and swimming-birds, such as Coots and Ducks, belong to the lower classes. We have fluffy coats from the beginning, and we are all very independent from the time we are hatched, and can move about hither and thither in search of food."

"Thank you, Chick Pheasant, for your very clear and full answer to my first question. As we have so often seen your father and mother clad in ordinary feathers like other birds, we need not ask you whether you will wear your woolly coat all your life.

But I *do* want to know from you, of what material is your nice, soft, fluffy coat composed? That is my second question. Is it fine hair, which we call fur?"

"Oh, no, *do* please remember that I am a little bird, not a mammal like Baby Bunny. My coat is composed of feathers better known as '*down*,' but I prefer you to call them '*down-feathers*.' (PL. VI. K.)

"Very good, little chick, you have answered my second question so accurately that presently I am going to tell you some interesting facts about your clothing and that of other

birds. But, in the meantime, see ; we must not keep Baby Bunny waiting : look at him sitting up on his hind-legs, eager and desirous of answering questions ! ”

BABY BUNNY'S POLITE BUT TIMID REPLY.

“ Well, Baby Bunny, I have only two simple questions to put, namely : of what material is your coat composed, and, will you wear it all your life ? ”

“ My coat, Sir, is very soft, being *true fur*, composed of very fine woolly hairs : I shall wear the same all my life, though, of course, new hairs will replace the old ones from time to time.”

“ Thank you, Baby Bunny, for your correct answer, so quietly and politely given. May I add, however, that should you be questioned another time, just try and speak a little louder ; I hardly caught your words distinctly.”

“ Very nervous, did you say ? Yes, I fully sympathise. In fact, I fully understand that it would be difficult, if not altogether impossible, to cure your timidity, seeing what hosts of enemies are constantly on your track. Now, if you are not in a hurry, will you take a seat beside Chick Pheasant, who, you see, has squatted down very close to the smallest child of our party. I want to tell you, presently, some very interesting facts about your coat, and the reason why you retain it unchanged.”

“ Ah ! but what about Mr. Caterpillar ? He also should be anxious to hear what I have to tell about his coat. Where is he ? Ask him to come forward !

MR. CATERPILLAR DROPS OFF TO SLEEP.

“ Curled up, asleep, under a leaf ? Surely never ? How very strange ! ”

Evidently *he* has not been particularly interested in the proceedings of this meeting ; better let him sleep on in peace : perhaps, after all, he has eaten far too greedily : and if we



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FIG. 23.—THE CATERPILLAR OF WONDERLAND.

"You remember, that when Alice . . . came across Mr. Caterpillar, seated upon a mushroom smoking a hookah, she found it was very difficult to make pleasant conversation."

roused him, he would be ruder than ever, and might spoil my stories by repeated interruptions. At the best of times we know that he is a cross-patch !

"Chick Pheasant, will you kindly shout in his ear? We shall then know if he be sound asleep or not; for we certainly do not wish to be interrupted by rude remarks."

"Fast asleep? Dear O dear! Aye; even pecking at him will not awaken him."

"I know you are hungry, little chick; so do not peck at Mr. Caterpillar too hard or you may be tempted to swallow him! You might enjoy the tit-bit: nevertheless, for you, as well as for the rest of us, the disappearance of Mr. Caterpillar would be little short of a disaster: we must have him among our party, even if he sleeps, until I have finished telling my three little stories."

Before I begin, let me take a peep at Mr. Caterpillar. Ah! no small wonder he could not be aroused from his slumbers. See! he has enclosed himself within a silken shell (we call it a cocoon); has lost the use of his sense-organs; cannot see, hear, smell, nor feel; has lost the power of moving about and taking food: and, in fact, may be said to be in a state of suspended animation! Open the silken shell, and you will see that he has lost his woolly jacket: his body appears as a soft mass, indefinite in shape.

MR. C. BECOMES MR. CHRYSALIS.

He has changed into Mr. Chrysalis. Mr. Caterpillar will, be unable, therefore, to hear my little story about himself. Perhaps he had forebodings that he would very soon become Mr. Chrysalis, and so, before growing speechless and deaf, he thought he would like to tell part of my story himself; which, after all, he did when answering my question.

Don't you remember that he rudely blurted out: "Long woolly hairs would be in my way when flying about. They would interfere with the movements of my wings. When I

change into Mr. Moth, my body will be covered with fine powder, which, when seen under the microscope, looks like a collection of thousands of tiny feathers."

Having thus almost taken the words out of my mouth (though expressed in very rude language which I should not have adopted), I have now but little more to add. Since Mr. Caterpillar is quite deprived of hearing the remaining chapter of my story, extremely short though it may be, I tell you what we shall do! We shall appoint Baby Bunny to keep an eye on Mr. Chrysalis, and when Mr. Moth flies forth from the silken case, then to tell him the tale.

"Do you agree, Baby Bunny?"

"With pleasure," I hear you remark? Best thanks!

THE STORY ABOUT BABY BUNNY'S COAT.

I think, Baby Bunny, that the story about you and your coat should be related in the first instance: it is a short and simple story, and from the other two stands well apart. So now, little Bunny and Pheasant, and all children, listen carefully, and let me have your best attention.

Bunny, my dear, you are a good example of a ground-animal. You were born in a burrow which, owing to your rapid development, you were able to leave in about three weeks' time, or perhaps earlier. You rapidly grew independent, and started scampering about hither and thither in search of grasses and other edible vegetable food. Though you were born clothed in very sparse, fine hair, you appeared at the mouth of the burrow when sixteen to twenty days old, already well dressed in a thick, furry coat, *exactly similar to that worn by your parents*. Cold weather, of course, may change the shade of your coat, though that is not usual in

our country. But the important thing to bear in mind is that the costume of your infancy is just the same as that which you will wear when you have become quite grown-up. We were delighted to hear that piece of information coming from your own lips! Now, when compared with Chick Pheasant or any other bird, or with Mr. Caterpillar, we find that your bodily structures and habits are framed upon a much more uniform plan. You will spend the days of your youth and the rest of your life amid the same surroundings. Indeed your folk will sometimes stick to the same area all their lives, an area comprising a run of perhaps but a few acres of ground. You adopt the same tactics as your parents, although, of course, you grow more timid and watchful as you become aware of the pitfalls which everywhere beset your path. Bunny, you are a little *mammal*, and the great class of animals, to which you belong (with comparatively few exceptions), has not become highly specialised. Look! You have retained the freedom of your fingers and toes; with your useful hands you can both burrow and wash your face! You have retained the free movement of your back-bone, whilst your limb-bones, and indeed the rest of your skeleton, conform to the more ordinary type. Little Rabbit, you are now beginning to understand how it is that you can manage to remain such an exact miniature of your parents, even to the colour and woolly texture of your coat. You are marked by general rather than by special characteristics, and Nature has ordained that no more harm will befall you in dressing in a similar garb to that of your Daddy and Mummy, than if you were clad quite differently.

So ends my story concerning you and your woolly dress, little Bunny.

THE STORY ABOUT CHICK PHEASANT'S COAT.

Little Chick Pheasant, I have quite another story to relate in regard to your dress. Think! How very differently you will be robed later on in life! Yes; but why? Surely because at present in your young '*chick-hood*' days, you are, like Bunny, a ground-animal, and, just like Bunny, you are clothed in a soft, woolly coat. But, unlike Bunny, you are going soon to make special use of your front-limbs, which, so far, have had nothing particular to do. Soon, by the accession of large and long feathers, your front-limbs will become great, mighty wings, which can be used to carry you through the air. What a wonderful and special use! Yes; and moreover, we all here know that your finger-bones, which form the skeleton of the outer part of your wings, have already become joined together, so that you have very strong hands, which, when provided with long, stiff, pointed, flight-feathers, are beautifully adapted, during rapid flight, to cut through the air like a flail. You have mentioned that your woolly coat is composed of *down-feathers*. Let me tell you that they closely resemble fine hairs called *fur*, till we examine them individually. The difference then becomes very real. Each down-feather is composed of a short, weak, stem, from which *several* soft, wavy *branches* spring. These are the *barbs*, which are present in nearly all feathers. In the stiff flight-feathers of your parents, where they form close webbing on each side of the shaft. (PL. VI. A.D.) *The hairs of mammals, whether coarse or fine, are not branched.*

A WORD IN PRIVATE.

Little Chick Pheasant, may I ask you to run away for a couple of minutes and look for something to eat; Baby Bunny will you please join him in the ramble?

I want to have a word in private.

Boys and girls, whisper ! You have seen a cook take a fowl, already plucked, and then singe it ? By this procedure the extremely slender thread-feathers (well-developed in the domestic fowl), can be removed as a final preparation before cooking. It is curious that these appendages should grow thinly scattered among the ordinary feathers on the adult bird. They more closely approach the hairs of mammals than do any other class of feather found on the bird's body, nestling or adult. But they differ from hairs in having a *terminal tuft of barbs*, the rest of the shaft being absolutely devoid of branches (*barbs*). They are technically termed *filoplumes*. (PL. VI. N.)

THE STORY RESUMED.

Come back, little Chick and Bunny. Hear, now, the rest of my story : I trust that both of you were lucky enough to find a few dainty morsels of food.

Not many days will elapse, little Chick before your fluffy coat of down-feathers, which we shall call *plumulae*, will be replaced by a coat of feathers proper, known as *plumæ*. Your entire dress will then be known as your juvenile *plumage*, consisting of a system of overlapping feathers arranged like tiles or slates on the roof of a house. But slates are immovably fixed ; on the contrary, you will be able to raise your feathers at will, and thereby ventilate your skin ; at the same time you will be able to preen each feather in turn until your whole plumage has been combed out. You will find your feathers curved in shape and very elastic : hence in flight, when you may want to present your body as a compact mass to the air, you will be able to close down all your feathers until they tightly overlap. You will have the power to rotate the long flight-feathers of your wings, so that they can be made

to separate and come together again, like the laths of a Venetian blind. In that way, any compressed air which is not needed can be liberated instantly from under your wings during flight.

Remember, little Chick, that birds are the only vertebrate creatures which can fly with *skin-appendages* (that is with feathers). Flying-reptiles and flying-mammals move through the air by the aid of *skin-expansions* which they cannot put to such an advantage as a bird can its wing-feathers.

Now, Little One, I think you will understand how it has come about that you, unlike Baby Bunny, are not in dress by any means an exact miniature of your parents. You are marked by special rather than by general characteristics: the ground claims you as a nestling: the air claims you as an adult. Therefore, unlike Baby Bunny, you surely must exchange your fluffy coat for a very different one, before you can resemble your Daddy and Mummy.

That completes my story about you, and your dress, little Chick Pheasant.

THE STORY ABOUT MR. CATERPILLAR'S COAT.

I must now tell my last story: it is a short one, because Mr. Caterpillar himself has already told us part of it.

You have just heard that a bird is a creature which, in structure and mode of life, is highly specialised.

“Isn't that so, Chick Pheasant?”

It is likewise the case in insects of many classes, which indeed become so highly specialised that not only must they alter their clothing, but also their whole appearance before reaching maturity. Mr. Caterpillar, whom we know turns eventually into Mr. Moth, is one of these highly specialised insects. When Mr. Moth sallies forth from that silken shell

lying at your feet, he will be able to hear from Baby Bunny the following part of my story which, alas! at this present moment, *being Mr. Chrysalis*, he cannot possibly understand. In his name however, I must at once unfold my narrative to the rest of the party here assembled.

Everyone knows, Mr. Chrysalis, that when you existed as Mr. Caterpillar, your dress was very different to that which you will wear later on. Now, why is this the case? Let me explain. You Sir, Baby Bunny, and Chick Pheasant, all begin life as ground-animals, clothed in nice woolly coats. Bunny sticks to the ground and retains his coat, which is quite as useful to him when he grows up: Chick Pheasant learns to fly, and throws off his fluffy ground-coat for a new one: you are about to exhibit a most startling transformation in your bodily appearance, directly you become Mr. Moth. Your immense wings (two on each side), will grow out from your body, and during the hours of darkness you will spend much of your time on the wing.

Could the woolly long-haired coat of your days of creeping and crawling be usefully retained? Surely not! We have already learned from your own 'lips,' when you were Mr. Caterpillar, the reason. Your immense, membranous wings could only make room for a covering of *minute, feather-like bodies, fine as dust to the naked eye*. Mr. Chrysalis, I think you will understand how it has happened that you now (and previously when you were Mr. Caterpillar), show no resemblances to your winged parents. You are marked by very special characteristics. The ground, the trees, the walls, and other spots, within reach of your creeping, crawling, powers, once claimed you as a fleshy, juicy, wingless, creature. The air will claim you as her own when you come forth a beautiful and active winged-insect, *Mr. Moth*.

And so Mr. Chrysalis, in supplanting Mr. Caterpillar's existence, not only had you to abandon your fluffy coat, but you also have still to undergo a startling change in form before you can resemble your parents in dress. How different from Bunny's simple case.

GOOD-BYE, LITTLE VISITORS.

But, my young friends, it is getting very late, so at last we must bid a hurried good-bye to our three little visitors, and quickly return to our room, and there assemble round the table on which we left our Herring-Gull lying, in order to study the plumage, more particularly because it is that of an adult bird.

Remember, little Pheasant, you are wearing the dress of a chick, and we must now study feathers proper !

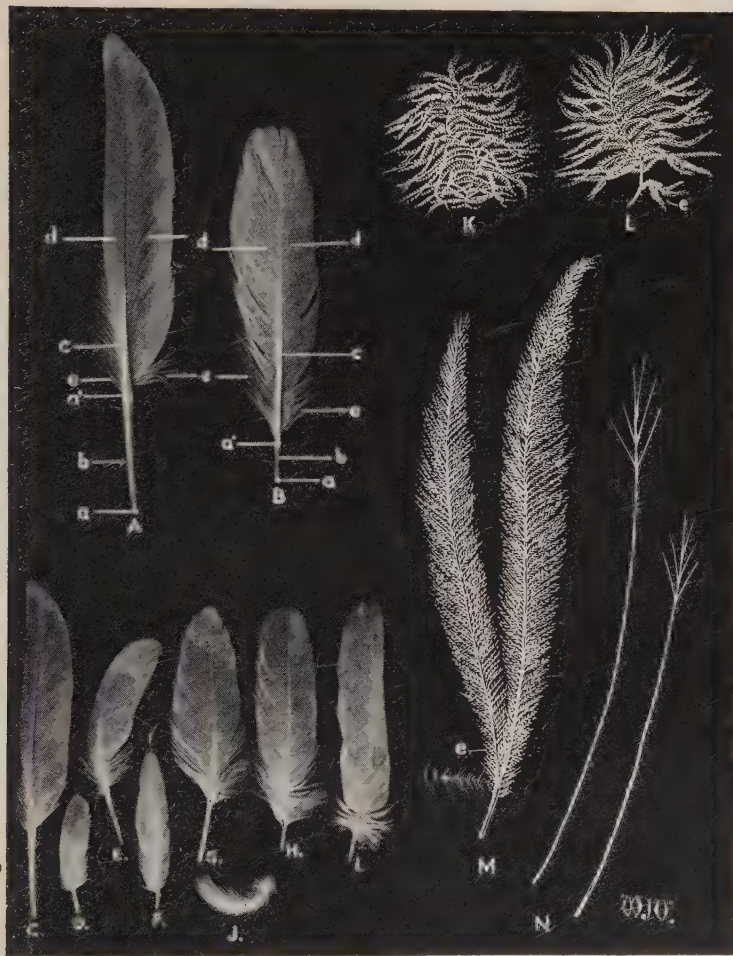
Good-bye, little visitors ; best thanks for your company.

Whisper, Bunny ! Please do not forget to tell Mr. Moth the rest of the story.

EXAMINATION OF HERRING-GULL'S FEATHERS.

" Let's pretend " that once more we are examining our dead Herring-Gull ; this time its plumage. How very fortunate for us that the bird had just commenced moulting—that is to say, shedding its feathers ! Look at the numbers which are coming out by a gentle pull ! Seize the chance and each of you take one for examination. We always learn much more by having a specimen to hand. Note that the feather is curved ; especially in the case of one taken from the breast. PL. VI. J.) The hollow or concave surface overlaps the raised or convex surface of the neighbouring feather. All of them in turn overlap except when they are raised, and in that way become separated. Try now to straighten your feather. Note how very readily it returns to its curved shape directly the pressure is taken off.

The Architecture of the Feathers.



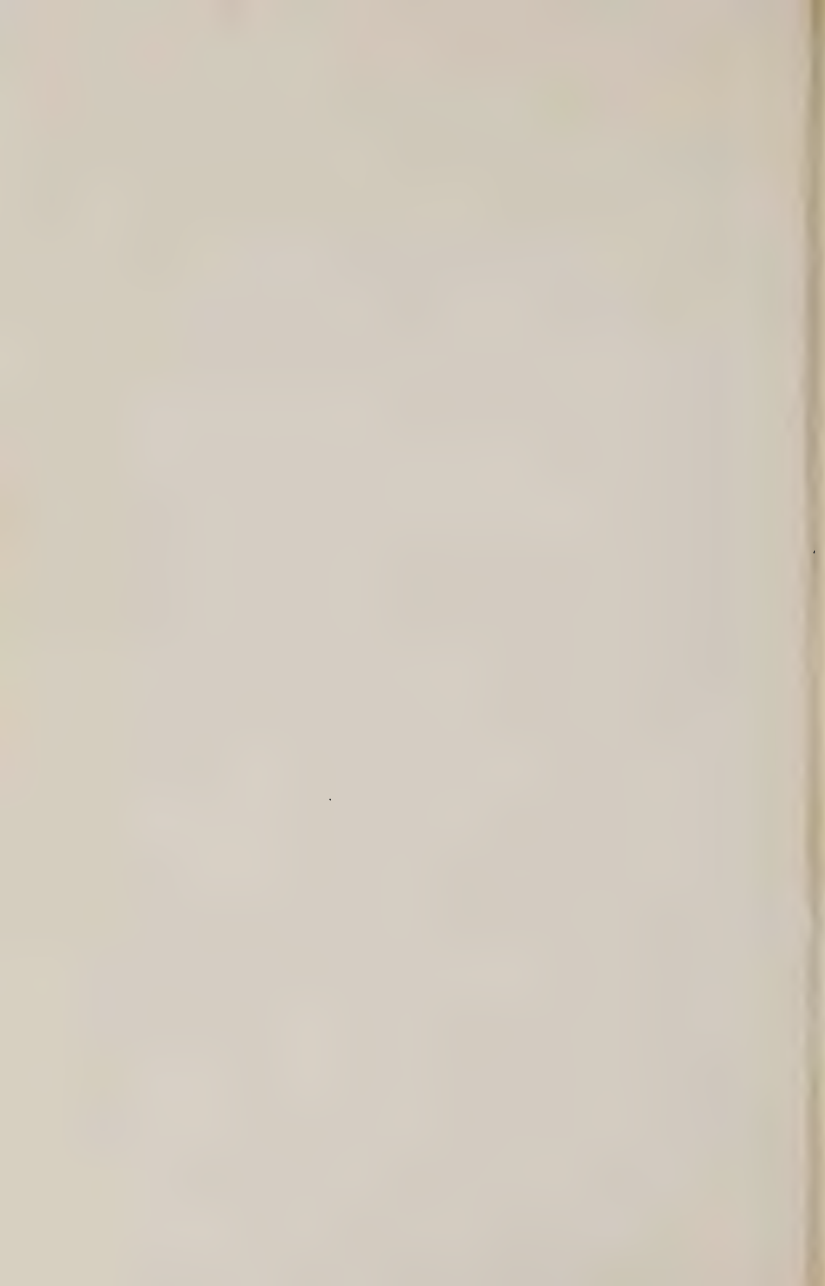
(Phot by the Author)

THE GENERAL FORM AND STRUCTURE IS INDICATED IN TWO TYPICAL LONG FEATHERS, NAMELY, FROM THE WING (A), FROM THE TAIL (B).

"The strands of the webbing are called barbs. They are kept together by smaller filaments called barbules, which bear minute hook-like processes."

a.—Pulp entrance. a'—Upper opening or pit. b.—Hollow barrel. c.—Solid shaft. d.—Webbing or vane. e.—'Aftershaft.'

[Continued on page 111.]



Try and derange the webbing on each side of the shaft by pulling the strands in a direction from tip to base. (PL. VI.A.)

BARBS AND BARBULES.

The strands of the webbing are called *barbs*. They are kept together by smaller filaments called *barbules*, which bear minute hook-like processes which hold the barbules and in turn the barbs, in close contact. That is why the webbing offered quite an appreciable amount of resistance when you proceeded to separate its strands or barbs. This is particularly noticeable in the case of the long stiff wing-feathers which are so intimately concerned in the mechanism of flight. Note that their outer webs are narrower, much more resisting, and also thicker, than those of the opposite side. It therefore follows that during the down-stroke of the wing, the resisting air acts more strongly upon the thinner inner webs, and presses them up in such a manner that each feather is brought into close contact by its broad inner margin with that of its fellow, which overlaps it on the side nearer the body. The concavity of the under surfaces of these flight-feathers is reduced by the air pressing upwards when the wing makes the powerful down-stroke. Directly the wings go up and the pressure of the air is taken off, the feathers fully regain their curvature owing to their elastic properties. (PL. VI. A. C.)

CURVATURE AND ELASTICITY.

Notice how nicely the long wing-feathers can be rotated to allow the air to pass between them, as light can pass through the opened laths of a Venetian blind. Observe how accurately the tail-feathers overlap, yet they can be readily separated into a broad fan. (Fig. 7, A.) In life, a bird can move its tail in many directions: it can be rotated, depressed, and elevated.

When the tail is sufficiently long and suitable in shape, it may function largely as a rudder in steering. In short-tailed birds, such for instance as our Herring-Gull, steering is mainly carried out by the bird tilting its *whole body* to one or other side, at the same time the expanse, angle, and rate of flap, of one or both wings, are adjusted to suit the purpose.

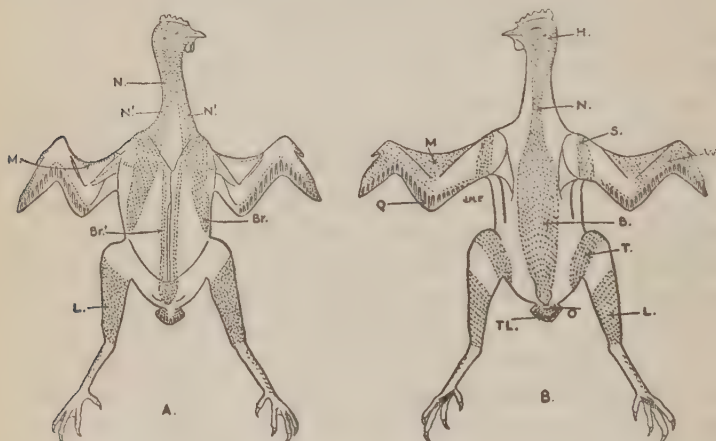


FIG. 24.—FEATHER-TRACTS IN THE FOWL.

A.—Front view.

B.—Back view.

H.—Head-tract. N.—Neck-tract. B.—Back-tract. N'.—Branches of Neck-tract. O.—Oil-tract. T.L.—Tail-tract. T.—Thigh-tract. L.—Leg-tract. Br.—Outer Breast-tract. Br'.—Inner Breast-tract. W.—Wing-tract. Q.—Quill-tract. M.—Wing-Membrane-tract. S.—Shoulder-tract.

Observe:—The neck-tract divides on the front or ventral side, then each branch diverges and passes continuously into the Outer Breast-tract. In many birds the Inner Breast-tract is absent. The general pattern of the tracts, as a whole, vary considerably in different classes of birds.

FEATHER-TRACTS.

It is very interesting to see that the plumage of a bird does not grow from all parts of the skin, but rather from well-defined *tracts*. Nevertheless the bare areas are easily covered by the ample size and spread of the feathers. Just raise the feathers

spread over the shoulders and middle of the breast ; here observe extensive featherless patches : there are others besides. (Fig.24.) Feathers on the whole are good regulators of temperature ; but they act as poor conductors of heat when they are lowered and made to overlap tightly, consequently the body is kept warm ; on the other hand when they are raised and separated the skin can be quite well ventilated. As a protective covering, feathers are not particularly efficient. Except in the case of aquatic birds they readily become water-logged. When fully soaked they are not only dragged, but also sufficiently weighted at times to interfere seriously with flight.

PRIMARY USE OF FEATHERS.

Lastly I would lay stress on the fact that *the primary use of all feathers, great and small, is intimately associated with flight.* The plumage of birds is a highly specialised clothing, developed to meet the needs of a highly specialised creature, which during the greater part of its existence is, in truth, a denizen of the air. The feathers of our Herring-Gull present no peculiarities in form or structure ; they are quite typical : therefore our bird may now be skinned to enable us to examine the deeper machinery of its body. However, before so doing, we shall learn in the next chapter some interesting facts in regard to curious, often weird, variations in plumages, and the special usage with which these are associated.

EXPLANATION OF PLATE VI.—CONTINUED.

C.—Flight-feather, from hand. Long barrel. Outer webbing narrow and stiff. D.—Cover of last. E.—Flight-feather, from forearm. Long barrel. Very curved. F.—Under wing-feather. Thin, narrow, straight, and pointed. G.—Flight-feather, from arm. Long barrel. Webbing straight and broad. H.—Middle tail-feather. Barrel short. Webbing straight, broad and even. I.—Outer tail-feather. Barrel short. Outer webbing narrow. J.—Body feather, from breast. Short. Very curved. Webbing loosely arranged. K.—Down-feather of nestling. Shaft very short. Webbing loose mesh-work. L.—Permanent down-feather. Shaft elongated. Aftershaft present. N.—Thread-feathers or filoplumes. Webbing absent. Barbs form a small terminal tuft.

Observe :—The minute barbules which spring from either side of the barbs in great numbers, are only visible to the naked eye where the barbs are loosely arranged, forming a soft meshwork. Multitudes of barbules are discernible in the down-feather and also in the basal tufts (Aftershaft), in adult feathers. This is usually short and insignificant. In some birds, notably the Emeu, the aftershaft, however, is nearly as long as the main webbing which is also loosely arranged. Hence barbules can be seen over the entire feather. Barbules should be viewed through a pocket-lens. Though visible to the naked eye, they are rather minute to study without magnification.

LECTURE 5.

CHAPTER VIII.

BIRDS AND THEIR COSTUMES.

A VARIED AND LIBERAL WARDROBE.

Avian infant's furry coat soon abandoned—Rapid growth—Juveniles as large as parents when first dress completed—The young robin's breast—How to tell a juvenile magpie—The plumage of our Herring-Gull—An adult male, adult female similar—Juveniles of both sexes, similar dress, but different from that of the parents—Adult plumage not completed till fifth year—Examination and description of the plumage of our Herring-Gull—We skin our bird and preserve the body. The skin becomes another Herring-Gull—A word on the art of taxidermy—We take our Herring-Gull to the Museum—The Curator is delighted with our gift—A glass-case of Herring-Gulls—Various juvenile and adolescent costumes—Our adult specimen completes the plumage-series—Herring-Gulls in two shades of 'tweed'—A study in plumages from the deck of a steamer—Two familiar garden-birds—Robin and Starling—Young dressed very differently from parents—Plumage in both sexes similar—Herring-Gull, Robin, Starling and many other birds follow same rule in regard to plumage-changes—Another plumage-rule—Juveniles of both sexes wear mother's dress, or one very like it, when father has a different one of his own—Familiar examples—Bullfinch, Chaffinch, House-Sparrow—Yet another interesting plumage-rule—When adult males of a well-defined family are very unlike, females and young, though different in species, resemble each other in plumage—In many species young and old of both sexes adopt a similar costume—Examples: Hedge-Sparrow, Wren, Magpie, Crow, Jay, Kingfisher—The problem of Protective Colouration—Fancy-dress—Wedding ornaments of adult males—Combs, wattles, horns, crests, frills, and others—Wedding or nuptial plumage, a special costume worn by birds in spring—The gorgeous livery of the male pleases the female.

THE nestling's plumage, well known as *down*, soft and woolly, and composed of a loosely arranged meshwork of feathers (*plumulæ*), is very soon supplanted by quite a different costume, composed of true feathers (*plumæ*). In water-birds the down is very thick and persistent, and provides a warm, comfortable under-clothing! This, however, soon becomes overlaid, in the first instance by the juvenile and later on by the adult plumage. The true feathers grow so very rapidly, that within a month after the chick has cracked his shell, he has acquired a complete dress, very similar in texture and structure to that of his parents. It seems almost incredible that in this brief period, the small, naked arms (you remember how strikingly they resemble our own), are transfigured into mighty wide-spreading wings. In this costume scarce completed, the youngster quits the nest, and at once embarks on some trial flights. In less than a week he has mastered his task, and fearlessly joins his parents and other older companions in their aerial excursions. Already, at this tender age, he is as big as his parents: indeed sometimes he looks bigger, notably when, in begging for food, he fluffs out his feathers. A young gull on the wing certainly looks quite as large as its accompanying parent.

JUVENILE DRESS.

An interesting question now arises,—Is the juvenile dress distinguishable? In some species, yes; in others, no.

I dare say that in summer you may have observed now and again in the garden, a robin with dusky, spotted breast-feathers? (PL. VIII. B.) He was then in juvenile plumage, before his brick-red 'waistcoat' had as yet appeared! On the other hand, the plumages of the magpie appear practically

identical at all ages. Now, if the juvenile bird be as big as its parents, have we any way of distinguishing the one from the others? Yes; the tail of the former is shorter. As a rule, when the tail of a bird is markedly long—as it is in the magpie—the full length is not reached at as early a date relatively as it would be in the case of a bird possessing a tail of shorter proportions. Having taken these two familiar garden-birds, by way of introduction, in regard to our studies of plumages, we find ourselves already in a position to make this definite statement: *Some species of young birds resemble their parents in the pattern and colouration of their plumage, while others differ in those respects.* I am very glad that we selected the robin; it proves an instructive illustration, because the rule—or indeed we may call it a law,—which pertains to its phases of plumage holds good in the main in the case of the bird which we have had so much to say about all along, namely, our Herring-Gull. In order to avoid repetition, it is advisable to make it clear at the outset, that when we speak of differences or similarities in plumage, it is to be understood—throughout this chapter—that we mean differences or similarities *in pattern and colouration.*

“Let’s pretend ” that we have assembled in a large circle round the table and that I am holding our Herring-Gull up by its feet (not legs, remember), in order that you may have a good view of the entire plumage. When a bird is suspended in this position, the wings droop and become partly spread by gravity; consequently we obtain a nice view of the long flight-feathers. I shall slowly turn the bird round so that we all may have an opportunity of seeing the upper and under plumage. In the first place let me say that this Herring-Gull when first picked up, had already attained its adult plumage, which in the male and female is similar; and in the second

Gulls and their Costumes.



A. HERRING-GULL, ADULT.

"The back and the wings are shaded in pleasing...french grey."



B. HERRING-GULL, IMMATURE.

"Here wearing a strikingly smart faced-suit."



C.—GREAT BLACK-BACKED GULL, ADULT.

"Or Royal Gull, the latter name being also familiar."



(Photos by the Author)
D. GLAUCOUS GULL, ADULT.

"Black markings are entirely absent from the flight-leathers of the Arctic Gulls."

place that the plumage of the young of both sexes is also identical; but quite unlike that worn by their parents. Curiously enough, as already mentioned, the Robin presents a parallel case, the only difference being that the adult Herring-Gull undergoes a slight seasonal change in plumage-markings, i.e., in winter and summer. (PL. VII. A.)

DESCRIPTION OF OUR HERRING-GULL'S PLUMAGE.

Look attentively at our specimen! Most of the plumage is pure white; but the middle of the back and the wings are shaded in pleasing, delicate pale blue-grey, known also as *pearl-grey* or *french-grey*. The long, powerful, stiff, flight-feathers (which spring from the hand), are chiefly black, tipped with white; in addition we observe larger white spots called 'eyes,' while the inner webs are beautifully shaded in pale-grey. The shorter flight-feathers (which we notice are markedly curved in outline and which spring from the forearm), are chiefly french-grey with white tips. Our bird is an adult male in summer-plumage, and I repeat, the adult female at the same time of year is exactly similar. Observe that the head is pure white. In the winter, however, in both sexes the head and upper part of the neck are streaked with pale dusky grey. In the head plumage of the robin no corresponding seasonal change takes place. (PL. VII. A.)

PLUMAGE OF ARCTIC GULLS.

Most of our gulls, when adult, conform to the plumage-pattern of the Herring-gull. It is noteworthy, however, that *black* markings are entirely absent from the flight-feathers of the Arctic gulls, with the result that their dress harmonises all the more closely with their surroundings of snow and ice. (PL. VII. D.) We have studied the external characters of our Herring-Gull far enough, so that we have

arrived at a stage when we can start to take off the skin; the latter should be preserved, stuffed, and mounted, for future reference. The skin must be removed very carefully because you recollect that the bird had commenced moulting and some of its feathers came away easily.

TAXIDERMY A DELIGHTFUL ART.

Skinning and stuffing birds successfully requires taste, delicacy of touch, great patience, and most diligent practice. The art is called *taxidermy*, and it should be mastered by all persons who earnestly desire to make birds a serious study. I taught myself, having culled the information from a series of delightful articles which appeared in the "Boys' Own Paper" many years ago, written by Dr. Gordon Stables, who published also several entrancing books for young folks. I was then a school-boy, but I have continued to practise taxidermy ever since, and for me it has developed not only into a most fascinating hobby, but it has also proved an invaluable, indeed indispensable, asset in the study of plumages and other aspects of bird-life. I had but little time to preserve birds during school-term; however when the love for setting up a bird and imitating life had thoroughly gripped me, it allured me from indulging in the more ordinary pastimes during the holidays. Vividly indeed do I remember rejoicing greatly on some occasions when the weather became too unfavourable to permit of outdoor occupation, because I was able to offer all the more plausible excuses for permission to slip away quietly and shut myself up in a lumber-room for several hours on end with bird, instruments, preservatives, etc. When thus occupied, many cold, gloomy days in the Christmas vacation were passed in keen enjoyment.

But we must return from this short digression, to our studies of bird-plumages.

WE VISIT THE MUSEUM.

"Let's pretend" that the skin of our Herring-Gull has been successfully preserved, stuffed and mounted, and that, having immersed the body in a jar of pickle, for future use, we all take the stuffed specimen to the Sheffield Museum and present it to the Curator, who graciously accepts the gift as one at present greatly needed.

"Look," says the Curator; "I have not a mature Herring-Gull mounted amongst the collection of thirty which you see in that glass-case!"

"You observe a fine series in different phases of immature dress and also in transition, otherwise known as adolescent, plumage. I wonder can the young people pick these out, supposing I turn round the stands and hide the labels?"

"I am afraid not, as yet; but if you would be so kind, Mr. Curator, as to allow me to take my class over the bird-collection, I feel sure that these keen and intelligent youngsters will soon learn much about the plumage of Herring-Gulls and other birds."

"The Museum is at your disposal with pleasure, sir; only excuse me, as I must be off to attend a meeting."

"Oh! thank you so much, Mr. Curator; we shall be highly delighted to learn more about the plumages of birds."

"Was it not kind of the Curator, boys and girls?"

HERRING-GULLS IN VARIOUS PHASES OF PLUMAGE.

Do you see that large bird on the second shelf from the bottom, in which not only the plumage, but also the beak, feet, and eyes, are markedly different from those of our Herring-Gull? Well, that is a Herring-Gull in its first year's plumage, though you would hardly credit the fact! Observe that its

costume is completely, and at the same time profusely, mottled or chequered in two shades of brown, light and dark ; while its long flight-feathers are almost entirely dark-brown, except the inner webs, which are paler in shade, and have the tips



J.M.F.

FIG. 26.—WE TAKE OUR HERRING-GULL TO THE MUSEUM.

"I wonder can the young people pick these out, supposing I turn round the stands and hide the labels?"

touched with white : also notice that the tail-feathers are broadly banded at their free ends with dark brown. Surely our youthful Herring-Gull is here wearing a strikingly smart *tweed-suit*, clearly defined and bold in pattern ! (PL. VII. B.) How nicely the dusky, brownish beak, feet, and eyes, blend in

harmonious colouration with the plumage, offering a marked contrast to the yellow beak with its red spot at the angle, the brilliant, straw-coloured eyes, and the pinkish, almost flesh-coloured, feet of the adult bird. Alongside, observe another specimen, quite similar in the tweed-pattern of its plumage, but distinctly lighter in shade. This is a Herring-Gull in its second year's dress ; the next one, which is showing some of the pearl or french-grey feathers on the centre of the back and shoulders, is in its third year's plumage : while the next of the series, in which a considerable amount of the tweed-pattern of the head, neck, and breast, has been replaced by white, and some of the smaller wing-feathers by french-grey, also in which the brown band of the tail is becoming broken up by white spots, is a Herring-Gull in its fourth year's plumage ; lastly, the bird which we have just presented to the Museum shows the fully-matured plumage, in which all traces of the tweed-pattern have been lost, and the tail has become pure white through the complete disappearance of the broad brown band. This plumage is not acquired until the *fifth year*, from which age onwards it is successively repeated at each moult. Our bird was therefore at least five years old, but of course it may have been older. The Herring-Gull is not fully matured until it is five years old, and it begins to breed only exceptionally before that age. This rule holds good in the case of several other common species of gulls which frequent our Isles, and which pass through the same lengthened periods with respect to plumage-changes. (PL. VII. A.B.)

HERRING-GULLS ASTERN OF THE STEAMER.

When next you visit the seaside, and more especially whenever you are afforded the opportunity of a trip in a steamer, just watch carefully the large gathering of Herring-

Gulls flying astern from port to port in search of food. Indeed, this very companionable, though voracious bird, depending to a considerable extent for its sustenance on floating garbage, appears quite indifferent to the shipping traffic of busy ports and harbours, where it may be seen perched on cargo-sheds, chimney-pots, factory-roofs, and on the gunwales and riggings of the boats. You are almost sure to see adults and young birds in the gatherings, and you will be impressed—especially on viewing these gulls from above as they skim lightly over the water—by their marked differences in plumage. When I was a boy I conceived the idea that a Herring-Gull in its first or second year's plumage was a different species altogether from the adult bird. To my mind the latter was the true Herring-Gull, and the former the '*Common Grey Gull*.' Needless to say, I invented the latter name. But as a little boy, with little knowledge of birds, it was far better to launch this conjecture than to take no notice whatsoever of the gull, because, later on, I grew all the more interested when I became acquainted with the curious plumage-changes, not only of the Herring-Gull, but also of many other species.

JUVENILE AND ADULT DRESS OF ROBIN AND STARLING.

Birds which come under this rule of plumage-changes are so very numerous and diversified that here reference can only be made concerning two of our very familiar garden-species, namely, the *Robin* and the *Starling*. Both come into the same category as the Herring-Gull, in regard to plumage. Adult robins, of both sexes, are alike; the young of both sexes are also alike, but differ from their parents. In what way? The young robin has not a red breast. (PL. VIII. B.) You are familiar with the starling,

❧ Juveniles unlike their Parents. ❧



A.—ROBIN, ADULT.

B.—ROBIN, JUVENILE.

"I dare say that in summer you may have observed now and again in the garden, a robin with dusky, spotted breast-feathers? He was then in juvenile plumage, before his brick-red 'waistcoat' had as yet appeared!"



(Photos by the Author.)

C.—STARLING, ADULT.

D.—STARLING, JUVENILE.

"You are familiar with the starling, clad in his glossy, blackish plumage, which exhibits a lively play of colours....But the juveniles of both sexes, whilst alike, differ markedly from their parents in having a dress of plain greyish-brown, without sheen and without pattern."

clad in his glossy, blackish plumage, which exhibits a lively play of colours in metallic green and purple sheen, with buff and whitish tips to the feathers. The female is almost identical, though admittedly less brilliant. But the juveniles of both sexes, whilst alike, differ markedly from their parents in having a dress of plain greyish-brown, without sheen and without pattern, shaded on the under-surface with white. (PL. VIII. D.) The young robin and the young starling are, as in the case of the Herring-Gull, quite unlike their parents. But it is very interesting to learn that the period during which the immature dress of our two familiar garden-birds is worn is ever so much shorter ; thus a robin or a starling which quits the nest in May or June fully feathered, sheds its juvenile plumage during September and October, and, with minor differences, already attains the plumage of its parents in the first winter of its existence. What a contrast when compared with the lengthened period which our Herring-Gull takes before completely discarding his several suits of 'tweed.' It seems to be the general rule for small birds to adopt their parents' dress early in their career if not from the very beginning. We have already mentioned the magpie as a good example of a bird which resembles its parents from the beginning ; the same applies to the kingfisher, the jay, and the crows. We shall return presently to consider a few points in connection with the birds which follow this sequence of plumage-changes.

PLUMAGE OF YOUNG BIRDS WHOSE PARENTS DIFFER IN DRESS.

In the meantime I want to indicate to you the rule usually adopted regarding the plumage of young birds when the parents differ from one another distinctly in their dress. In by far the majority of cases it is the father which is the

more conspicuous, not only in pattern but also in gaiety of colouration, and more often than not he is endowed with quite a beautiful dress. In such a case the young of both sexes usually put on a quiet costume, almost similar to that worn by their mother. Vast numbers from many classes follow this rule, such for instance as ducks, fowls, hawks and finches. In some birds the *pattern* of the plumage remains practically the same in the parents, but the colours are often very different and distinctive. The male bullfinch, with his lovely rosy-red breast and delicately tinted 'french' blue-grey back, his satin-black cap, wings, and tail, and white tail-coverts, looks like an exquisitely coloured photograph compared with his wife in her somewhat monochrome garb. The same may be said of the male chaffinch with his salmon-coloured breast and face, rich chestnut-brown back, light slate-blue cap, and attractive black and white wings. His wife may be looked upon appropriately as the 'uncoloured photograph,' for, apart from the white bars on her wings and a little blush of olive-green over the root of her tail, she is clad in a modest sandy-buff (otherwise drab or fawn-coloured) cloak. Young chaffinches and bullfinches follow closely their mothers in dress, but in the case of the young bullfinch the 'photograph,' *still figuratively speaking*, is made plainer through the absence of black on the head; so that the general shade of the bird is toned down to greyish or pale brown, relieved only by some white tail-coverts.

PLUMAGE OF JUVENILE AND ADULT SPARROWS.

But what are those two small birds in that glass-case with hosts of other familiar species. The adult male, mark you, differs not only in colouration but also in *pattern* of plumage. The pair evidently belong to the same species,

for we notice that four fully-feathered nestlings have been mounted upon the same stand, the whole forming a family-group. These birds are sparrows? You are right! They represent a family-group of the Common (or to speak more correctly), the House-Sparrow. Which of the adult birds is the male? I suppose you can almost guess that it is the one with the handsome coal-black throat-gorget, whitish cheeks, ashy-grey cap and tail-coverts, and rich mahogany-red back and wings? (PL. IX. D.) Have you noticed male sparrows about the streets and gardens of Sheffield, looking so nice and bright and clearly marked? No; I fear not. And why? Because in the first place the plumage of city-dwelling sparrows becomes easily impregnated with soot and other matter which sullies the purity of the colours; and in the second place it is in the spring only that these markings are so pronounced, although the black throat and other distinctive plumage-markings of the male are never lost; they are really only somewhat obscured in autumn and winter-dress.

In the third place (and this is the most important point to bear in mind) the young male birds throughout their first summer and autumn seasons show no sign of black on their throats. (PL. IX. C.) Nay more; when they have discarded their juvenile garb and have appeared in their first winter-dress, the black gorget on their throats is as yet inconspicuous. Notice that the mother-bird is very plain; indeed she wears a sombre-plumed dress of greyish or drab-brown, almost uniform in shade: hence she differs markedly in colouration from her mate. But how does she differ in the pattern of her plumage? Pronouncedly, in that she wears no black throat-gorget, but in addition, as already indicated, she shews none of the strongly contrasted colours above

described, which distinguish the rest of the plumage of the male. Turn your attention to the group of four young birds. Let us for the moment suppose that two of them are males and two females ; can we tell the differences in the sexes by looking at the plumage ? Surely not ; for remember I pointed out that the juvenile plumage in both sexes is indistinguishable. What else is observable about these young birds ? Their dress is almost identical with that of their mother. (PL. IX. A.B.C.) Finally, how many members in this family-group are alike in dress ? Five out of the six. Yes ; that is an important point to bear in mind.

A MAGIC TRIP TO THE GARDEN.

“ Let’s pretend ” that suddenly we have been transported to the garden and now find ourselves feeding the birds. Not many moments elapse before we see large numbers of sparrows—*representing several family-groups*—bouncing actively about the lawn and flower-beds. Note, some cluster together, others keep more to the outskirts, others dodge in and out among the plants, and so you can readily understand that it would be impossible to keep all the birds in view at the same time.

WHY THE ADULT MALE SPARROW IS OVERLOOKED.

Now we have the key to the situation : the adult males, we know, are already greatly in the minority, namely, one to five ; therefore it is easy to comprehend how a considerable proportion of them might be overlooked, although their plumage differs from that of the adult females and young. You will understand also why people so often say, in speaking of the House-Sparrow : Oh aye ; I know the impudent little

68 An Adult Male in Smart Attire.



Pl. by W. Wood

- A. Juvenile Female.
- B. Adult Female.
- C. Juvenile Male.
- D. Adult Male.
- L. Adult Male.

FAMILY-GROUP OF THE HOUSE-SPARROW.

"Turn your attention to the group of four young birds,....can we tell the differences in the sexes by looking at the plumage? Surely not...the juvenile plumage in both sexes is indistinguishable....Their dress is almost identical with that of their mother....The adult male....in his courtng-coat in the spring is a clean, gay, smart, fellow."

creature, but must confess that I am not much interested; the plumage is far too dull and soot-sodden. I hope, my young friends, that you see the force of these remarks.

The adult male sparrow, the smartly-dressed member of the family-group, is very frequently overlooked; consequently all sparrows, of both sexes, of all ages, and at all seasons, are passed over as dirty, dull, dowdy birds! Far from it. A male, in his courting-coat in the spring, is a clean, gay, smart, fellow. (PL. IX. D.)

But we must hasten back to the Museum, and say adieu for the present to the sparrows, those hardy, energetic companions of Man, always first at his door-step to receive the breakfast crumbs.

MALES OF A FAMILY UNLIKE—FEMALES AND YOUNG ALIKE.

We should at this stage of our studies take notice of an interesting rule concerning certain birds, the plumage-changes of which come under the above-mentioned rule.

When the males of different kinds of birds—*but, mark you, belonging to the same family*—depart widely in plumage not only from their respective females, but also from each other, then *all* the females as well as the young, (though different in species), show a fairly close resemblance to one another in the general shade and pattern of the plumage. Look at that case of birds, for instance, now exactly facing us. It contains three well-known members of the *Grouse-family*, namely, the capercallie, the blackcock, and the red grouse; these birds serve to illustrate precisely what I have said. Observe that each adult male is very dissimilar, yet the plumage of the respective females and young is greyish and mottled.

But we must soon leave the Museum, so let us hurry up and make a rapid inspection of a few familiar birds in which the young and adults of both sexes are very similar, if not quite identical in their dress.

YOUNG AND ADULTS ALIKE.

First of all there are the modestly attired brownish birds the feathers of which are streaked or spotted, forming a subdued pattern. Observe on that shelf to the right a hedge-sparrow and a little wren, each set up upon a perch with their mates and juvenile offsprings. All are quietly attired, the young and adults in each of the two species being practically indistinguishable. Then look at the various kinds of thrushes, also of the mottled type of plumage, though much bolder in pattern, in which in the majority of species, the adults and young are almost alike. Even in the exceptional case of the blackbird—a member of the *Thrush-family*—in which the male differs in plumage from the female, we find that the latter and young conform to the *thrush-plumage* in being plain brownish above and mottled below on the breast. The question arises: why should a subdued mottled or streaked brownish plumage predominate? Not only in the birds which we have examined, but also in many other species far too numerous to investigate, we find that subdued plumages lead the van. We must remember that apart from those which exhibit this type of plumage throughout life, quite irrespective of age or sex, the young and females of other birds adopt the same type of plumage, although the males depart widely from it. The reason seems to be that mottled and dusky plumage can be traced far away back in the history of the bird's evolution. It is in other words a very ancient design in costume.

ANCIENT DRESS MOTTLED.

There is good reason to infer that in the remote past, this mottled dress was much more prevalent than it is at the present day. It prevailed and became widely distributed because it closely harmonised with natural surroundings, serving the useful purpose of preventing birds from being discovered by their enemies. Indubitably, in no small measure, subdued plumage still serves the same purpose. It has therefore been inherited and, as we have already pointed out, still predominates. Nevertheless, as years rolled on, many species learned to adapt themselves so well to their natural surroundings, and became so capable in the competition for life, that they have been able to thrive and flourish, even when dressed in conspicuous colours.

SURVIVAL OF CONSPICUOUS PLUMAGE.

That is why our noticeable black-and-white magpie, our jet-black crow, our bright blue-winged jay, and above all our kingfisher (whose brilliant emerald and sapphire plumes flash like a jewel as he darts over stream), hold their own so tenaciously. Furthermore, let it be remembered that not only in each of these birds are the adult male and female alike in plumage, but also that the young (in which the sexes are indistinguishable by the plumage) are arrayed in the garb of their parents from the very beginning. The crafty, clever, magpie, in his conspicuous piebald dress, comes under the same plumage-rule as the unobtrusive and modestly attired little hedge-sparrow: in both cases the males resemble the females, and the young of both sexes in turn resemble them.

Such then are the main features in regard to the plumage-changes of birds and the rules or 'laws' under

which they come to be associated. Very much more could be mentioned on such a wide subject, but space here will not permit. However, before leaving the Museum, we just happen to have a spare moment to look at that row of shelves on the left, specially set apart for specimens which possess richly ornamental plumes, brilliantly coloured combs, wattles, horns, and other weird appendages.

ORNAMENTAL DRESS.

Look ! here are head-crests, popularly called 'top-knots,' neck-frills, and feather-clusters, beautiful, long, and wavy, growing from various parts of the body. Some of these, as we see in the egret, and in other species of herons, are exquisitely fine and delicate in texture. Look also at the stupendous length and the surpassing beauty of the Peacock's tail-coverts, erected into a gorgeous fan ! Again ; look at the extremely long, slender, metallic-blue, wire-like feathers in the tail of a Bird-of-Paradise ! Then there is this curious 'neck-frill' on that bird, aptly labelled a ruff. In another specimen we are most fortunate in seeing it set up with its 'frill' spread—or we generally say erected—in such a circular manner that it resembles a perfectly fascinating little shield !

Now, we naturally ask, what do these curious, and in some cases decidedly weird, appendages signify ? Mind you, there are many other varieties in the museum besides these, which we have not time to inspect. Well, we are pretty safe in arriving at the conclusion that these appendages are worn for decorative purposes : the males don them to add to the beauty and interest of the wedding-garb ! In the spring, when birds pair and wed, the wives become greatly pleased and excited when their proud and vigorous husbands shew off their fineries to the very best advantage. (PL. X. A.B.)

Ornamental Liveries.



A.—RED BIRD-OF-PARADISE.

In the male (upper figure) observe the rich crimson, long, wavy side-plumes. The two middle tail-feathers, twenty-two inches long, are spirally twisted, and form elegant, double curved ribands. The female (lower figure) is clad in sombre brown, and she is devoid of decorative plumes.



B.—HUMMING-BIRD.

In this graceful, richly-plumed species, called *Lesbia*, the male (left figure) is endowed with beautiful elongated outer tail-plumes, which diverge to form an attractive V-shaped appendage. The dress of the female (right figure) is quietly speckled, and the tail is of ordinary dimensions.

(Photos by the Author.)

MALES DISPLAY THEIR WEDDING-COSTUME.

Who among us is not familiar with the impressive spectacle of the haughty peacock, when facing about to his mate, he erects into a fan his immensely long and gorgeous tail-coverts, disclosing the unique beauty of the so-called 'eye-spots,' which in turn form a magnificent back-ground, blending in harmony with his superb azure-blue throat and breast? Moreover, have we not *noticed* these wondrous feathers quivering from stem to stern, yes; have we not *heard* them rattling as he endeavours to draw still further attention? And who has not beheld the charming—we might even go so far as to say romantic—little goldfinch opening his wings, even in captivity, to display his brilliant sulphur-yellow bars to his mate, all the while swaying his body from side to side in a most enticing manner, to ensure that his wing-bars may produce a dazzlingly golden, flashing effect! The blackcap pays court to his wife by erecting his little head-dress—the only conspicuous plumes which he possesses. The wheatear spreads and raises the noticeable black and white feathers of his tail; while the redstart fans and flicks his tail of glowing fire. Much more might be said in regard to plumage-display if only space permitted. We must however conclude by remembering that decorations in some birds may grow so cumbersome as to interfere seriously with the powers of flight, and in other birds may serve to attract enemies. Nevertheless, the wearers have managed to survive and, as we have seen, can display them with most advantageous results.

But look out! my dear young friends, the doorkeeper is just on the point of closing the Museum.

We must hasten away, or we shall be locked up all night with the birds!

A FORECAST OF PRACTICAL WORK.

In the succeeding chapter, we shall embark upon a novel and an attractive phase of our studies. We shall actually proceed with a little practical anatomy, making bold to perform, for the first time, a few simple dissections. We have done with our Herring-Gull's feathers : we have also done with the skin. Strangely enough, the latter has been transfigured into another Herring-Gull ! Additional material will consist of a series of birds from which the skin has been already removed. It seems a trifle weird to think that we can still place upon the table for purposes of anatomical study, almost the whole of our Herring-Gull's body, yet when we visit the museum we see our bird looking splendid, and occupying an important and a most dignified position behind the polished glass of a beautiful cabinet !

Our preliminary operation will consist in stripping the fatty and membranaceous 'wrappers' which occupy a position immediately subjacent to the skin. The muscles, then laid bare, will at once engage our attention. We shall deal with them in a general rather than a technical manner, and mainly from the standpoint of mechanism as it subserves the various movements of the limbs.

LECTURE 6.

CHAPTER IX.

THE MECHANICS OF MUSCLES.

A PRETTY DEMONSTRATION ON THE DEAD BIRD.

What is a 'stuffed bird.'—More hints on the art of taxidermy—Making and wiring the 'false' body—Removing the natural and inserting the glass-eyes—Our Herring-Gull's 'double'—Story of a woodcock for dinner—Its appearance in the museum—The natural body of our Herring-Gull preserved for anatomical study—Machinery beneath the skin—A dissection performed on skinned rooks to demonstrate the actions of limb-muscles—The part played by flesh and tendon—Simple mechanism of direct haulage—Division of a muscle into several tendons—Illustration—The driver, his reins, and horses—Pulley-systems applied to muscular actions—Reduction of labour—Cutting and lowering a large branch of a tree—Gigantic crane at work—Opposite movements—Power and weight—Muscles working on pulley-system—The muscle's angular pull—Labour reduced—Breast-muscles—Heavy duty—Powerful direct haulage machinery—Mechanics of lowering human arm—Muscles and gravity—Special work of Greater Breast-muscle—High resistance offered to down-stroke of wing—Need of lever and fulcrum to support body in flight—Lesser Breast-muscle—Action—Pulley-system—Up-stroke of wing a light task—Factors besides muscular action.

GATHER around the table, my dear young friends, as quickly as you can, because I wish to show you the manner in which those wonderfully interesting structures we call muscles carry out their work. We shall confine our attention almost entirely to the study of the muscles of the limbs, and, as a preliminary business, we must carefully take

note of their form and attachments. I am glad to see that you have not forgotten to remove the carcase of our Herring-Gull from the jar of pickle in which we placed it for further preservation. I shall first soak up the superfluous moisture from our specimen with a sponge.

Notice that the head and parts of the wings and legs (including of course the feet and toes) are missing. Where are they? Surely you remember that they have been severed from the body and left intact in the skin, in conjunction with which they have been cleaned (that is to say the flesh removed from the bones), preserved, and made adjustable by wiring them to the artificial body of our stuffed specimen.

What then constitutes a 'stuffed' bird? It is most essential to remember that (excepting a stuffed turkey or goose which has just come out of the oven) it is the *skin* of a bird into which a rigid false body has been inserted and most accurately fitted. Indeed I know many naturalists who much prefer to call a 'stuffed' bird a 'mounted' skin!

HINTS ON BIRD-STUFFING.

The false body is usually composed of fine tow, firmly wrapped round an artificial vertebral column composed of wire; or, if it be preferred, a body may be carefully carved and modelled from a piece of fine dry peat or cork. You may truthfully tell your friends when viewing the birds in a glass-case in the museum, that they are looking at stuffed skins. You ask me how the eyes are preserved? Indeed a very sensible question; because a first-rate taxidermist can set the artificial ones so well that they appear astonishingly natural. Glass-eyes are substituted for the natural ones after the latter have been removed from their sockets, or,

what we call technically their *orbits*. The eyes are removed during the operation of peeling the skin off the head ; the artificial ones are put in from the outside later on, that is to say through the openings between the eye-lids, after the skin has been returned and readjusted over the head. The skin is turned inside out when it is peeled off the head, similar to the way in which the fingers of a tightly-fitting glove behave when withdrawing them from the hand. Our Herring-Gull has been most successfully stuffed and mounted ; he looks as elegant and natural as though he were alive. Observe that the eyes have been extremely well set, imparting a quite watchful, astute, gull-like expression of countenance. It seems rather hard to realise that with the exception of the head, and parts of the upper and lower limbs, we have still before us our entire Herring-Gull's body containing its machinery which must now engage our attention.

STORY OF A WOODCOCK.

Here, however, I am first reminded of a remark which I made to a couple of school-friends many years ago.

" Do you see that fine woodcock which I have set up, and made to look so sleek, plump, and comfortable, with his head nicely sunk between his shoulders, imparting to him an easy, restful pose ? Well, I have eaten him ! "

" I do not understand," one of my companions remarked.

I laughingly replied : " I have not eaten the skin ! " (Fig. 26.)

Remember, we have been enabled already to investigate some parts of the bird's machinery before we took the skin off the body of our Herring-Gull. We were in a position to examine the bones and joints because we managed to procure an excellent skeleton at Mr. Naturalist's shop.

We were, moreover, afforded the opportunity of examining, by the sense of touch, the great muscles attached to the keel and rest of the under surface of the breast-bone. Recall to your minds the fact that muscles, when attached from one bone to another, can move the joint (always provided it be a movable one) which connects the



FIG. 26.—THE WOODCOCK'S 'DOUBLE.'

"I laughingly replied, 'I have not eaten the skin.'"

two bones together. Other muscles, unconnected with the skeleton, do not here call for attention. But certain muscles, which we shall distinguish as *skeletal* (that is to say, have their attachments to bones), require investigation, although some of these have been already partly examined.

A ROOK APIECE AND A PAIR OF SCISSORS.

We are about to study the limb-muscles ; but the wings and legs of our Herring-Gull have been severed, for the most part, from the body. Therefore "let's pretend" that we are putting the carcass aside for a little while, and that I am handing to each of you a convenient-sized bird instead, say a rook, already skinned ; and further, that I am also providing you each with a nice pair of sharp scissors. We are now ready to carry out a highly interesting piece of practical work, which when finished, will enable us to demonstrate clearly the actions of some of the limb-muscles. Observe ! a number of muscles, (much smaller than the great breast-muscles), run out along the wings and down the legs. The fleshy portions, when traced out from the body, give rise to narrow cord-like structures, we call *tendons*. Muscles, which by their action produce precise and very rapid movements usually end in long tendons. (Fig. 27. Fig. 32, at. j.)

DEMONSTRATING THE ACTIONS OF LIMB-MUSCLES.

With your scissors snip neatly through several of these muscles close to where they take origin from the bones, that is to say as remote as possible from their tendinous extremities. Raise the cut muscles from the bone so that they may hang down quite freely. Take hold of one of the wing-muscles and steadily pull it : note, it bends the elbow : proceed to test other muscles and you will discover for yourselves the one which straightens out the wing at the elbow ; note, that yet another muscle when pulled, carries round the edge of the hand so extensively that it nearly makes contact with the fore-wing. Proceed with the muscles of the hind-limb similarly, and you will soon find a muscle which extends or straightens out the claws, and another which

bends them so that they approach each other, as they would when the living bird tightly clasps the perch. In life, the

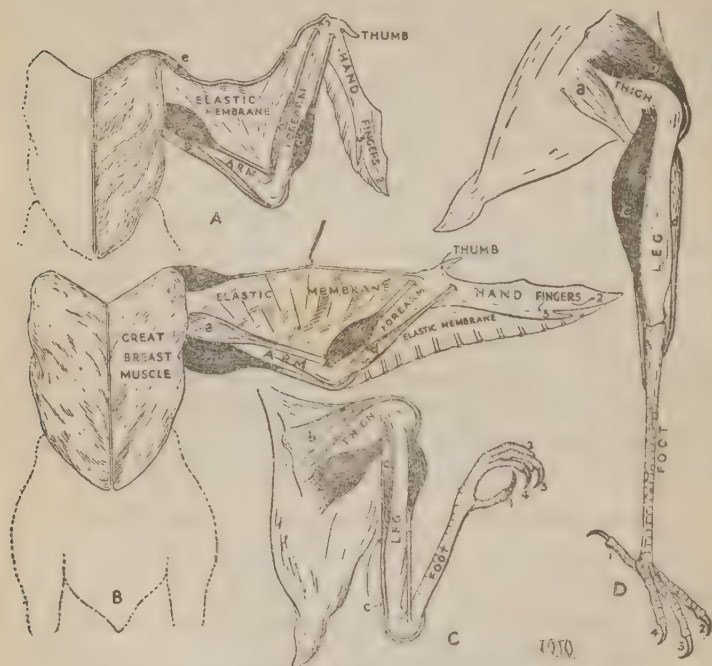


FIG. 27.—THE MECHANISM OF FOLDING AND EXTENDING THE LIMBS.

Muscles, in action, short, thick, and darkly shaded.

A.—Tendon of A, attached below *front* of elbow-joint. Muscle pulls forearm towards arm. (elbow bent). Tendon of D, attached below wrist-joint. Muscle pull hand towards forearm. (wrist bent). B.—Tendon of B, attached below *back* of elbow-joint. Muscle pulls forearm from arm. (elbow extended). Tendon of c, attached above wrist-joint. Muscle pulls hand from forearm. (wrist extended). This extension is augmented by the action of muscle E, which at the same time tightens the upper and larger elastic membrane. C.—Tendon of A, attached below *back* of knee-joint. Muscle pulls leg towards thigh. (knee bent). Tendon of D, attached below *front* of ankle-joint. Muscle pulls foot towards leg. (ankle bent). D.—Tendon of B, attached below *front* of knee-joint. Muscle pulls leg from thigh. (knee extended). Tendon of c, attached below *back* of ankle-joint. Muscle pulls foot from leg. (ankle extended). Observe:—In C, the toes are flexed because their tendon, in passing round the ankle-joint, is put upon a great strain. Compare Fig. 31. j. in which this tendon is figured.

fleshy part of the muscles, which you have detached from the bone and then pulled, can contract, that is, shorten at will,

The fleshy masses, in contracting, pull their tendons, producing results precisely similar to those which you have been able to demonstrate artificially when pulling the detached fleshy parts of the muscles in your dead birds. Surely, you have had now a very pretty demonstration on the action of limb-muscles! I shall not attempt to name the muscles, more especially as they are usually given in Latin. To make matters severely technical and tedious we find that two, three, or more words are often employed collectively for the name of a single muscle.

MUSCULAR MECHANISM BY DIRECT HAULAGE.

But there are a few points of great interest in regard to the mechanics of muscles, associated with various actions, which we shall here take particular notice of from the general stand-point.

Several muscles of the limbs, and indeed we may include of the trunk also, pull upon the structures, which they wish to move, in a straight or approximately a straight line. Mechanism obviously here is of the most simple kind. The particular muscle pulls the particular bone, or perhaps more than only one bone. The particular rope pulls the particular truck or boat. A pair of reins offers a good comparison. They represent at their origin (I mean where grasped in the driver's hand) the single muscle. If they are arranged to divide so as to control and pull up several horses, then they represent a muscle which branches into several tendons, each of which acts accordingly upon one of a group of structures. Thus the last joints of all our fingers (excepting our thumb), are made to bend forwards by one muscle arising in the forearm, which subdivides in the hand, into four beautiful long, narrow, tendons, each of which travels down and is attached to the

lowest bone (phalanx) of the respective finger. Similarly, a single muscle subdivides, and its four tendons bend the middle joints of our same four fingers.



J.M.F.

FIG. 28.—HOW WE CUT AND LOWERED A LARGE HEAVY BRANCH.

"We know how steadily the branch can be lowered by the person who picks up the rope lying on the ground, and gradually pays it out."

HAULAGE BY PULLEYS.

Muscles then may be aptly regarded as the haulage apparatus of the body. But we know that in hauling an article of considerable weight, our labours are greatly lessened

if the haul be carried round a pulley, or, still more so, round a system of pulleys. We wish to cut down a large branch of a tree and, at the same time, to lower it gently to the ground so as to prevent damaging our flower-beds or trellis-work. What should we do under the circumstances? Will it be quite sufficient to secure the branch in the first instance by lashing it with a rope to an adjacent branch? No; for when the rope round the adjacent branch was being unfastened, it would be impossible to prevent the cut one from coming down with an awful crash. The weight would be so tremendous that the rope would slip clean through our hands! The rope must not only be made secure around the branch you wish to cut, but it must be sufficiently long to pass round a higher branch and then down to the ground. We know how steadily the branch can be lowered by the person who picks up the rope lying on the ground, and gradually pays it out. He can even stop at will and let his ponderous load swing in mid-air as long as he holds on to the rope. Why can the branch be lowered by one man so easily? Because its dead-weight is greatly lessened by the rope in passing round a pulley, here represented by the upper branch.

During building operations; the loading and unloading of a ship's cargo; and in many other occupations; you must have noticed enormously heavy material being swung up and lowered by a rope which passes round the pulley of a gigantic crane or derrick. You also will have noticed that the direction of pull or traction and that of the material pulled is opposite, with the result that when the rope is pulled down the weight ascends, and *vice versa*. Now it so happens that there are muscles scattered over many regions of the body, in which the direction of pull is adapted in varying degrees to the pulley-system. The tendon of a long slender muscle in the

eye-socket or orbit, in passing forwards, enters a little ring of tough (or what we call fibrous) tissue, and then suddenly changes its direction by passing backwards to reach the eyeball more than half way behind its front pole. This is about the neatest example one could pick out of a muscle working on the pulley-system. But there are plenty of other muscles which, while not provided with so efficient a pulley-system, nevertheless are relieved considerably of the dead-weight which they are called upon to move, by taking an angular course from their fleshy origin to their tendinous insertion. Thus the muscle which straightens out the bent elbow passes round a salient corner of bone, and the angular traction only quite disappears when the limb is fully extended. (Fig. 27, A.B., b.)

DIRECT HAULAGE-ACTION BY GIANT BREAST-MUSCLES.

By the way, I think it is a matter of great interest to bear in mind that the enormously-developed avian breast-muscles which we have already noticed in a previous chapter, pass directly outwards, each to its respective humerus, which you may remember is the bone of the upper region of the front-limb or *arm proper*, as distinguished from the forearm. These muscles in lowering the wings have a heavy duty to perform, but their huge strength is equal to the occasion: nor is the load at all lightened by any system of pulleys. Indeed these giant muscles by their action demonstrate in a most striking manner the vast power of the haulage machinery of the body. We must keep this fact clearly before our minds that it is not a matter of the breast-muscles simply pulling down the elevated bony and fleshy framework of the wings. A muscle a hundred-fold smaller and weaker would suffice if only that were required. Raise your own arms high above your head: see how easily they can be

lowered quickly or slowly at will, and yet here the haulage machinery is very weak and insignificant when compared with that in a bird.

THE MECHANICS OF LOWERING OUR ARMS.

It is very important to bear in mind that when our body (I mean the trunk apart from the limbs), is in the upright posture, whether we choose to sit or stand, the action of the breast-muscles can in a large measure be dispensed with in favour of gravity. In other words the arm will, if given full liberty, drop by its own weight. The descending limb gathers momentum and strikes against the body with considerable force. No appreciable resistance to the fall is offered; gravity holds full sway. But even if we put the question of gravity out of court, it can be shewn that our much less powerful breast-muscles can easily haul down our arms, and we can repeat by practice the hauling exercise for a long period without a break. Will one of you be good enough to lie down at full length on your back on the carpet: now raise your arms as high as possible above your head and then, keeping them all the while in contact with the carpet, proceed to lower them, until they are brought against the sides of your body. Here obviously the entire down-stroke of the arm has been effected by muscular action unaided by gravity. The movement is of uniform speed and even when muscular action is geared up to the highest strain and consequently the speed of movement increased to its utmost, we still see that the arm cannot 'bump' or 'bang' against the body-wall with a rebound. The possibility of gathered momentum, due to gravity, is out of the question.

Let us consider, in a very general way, the kind of special haulage work that is thrown upon the great breast-muscles of

the bird. To think of a bird flying without feathers—a bird so completely naked as a plucked fowl,—is to our minds most absurd. We might as well try and fly ourselves by lifting and lowering our arms! But why is the idea so absurd? Because we know that the naked wing-surface is very much too small and narrow to encompass and compress a large mass of air underneath it during the down-stroke, and thereby give support to the body in passing through the air. Hence the bird has acquired a system of feathers which has added enormously to the insignificant area of its naked wing.

GREAT RESISTANCE OFFERED TO DOWN-STROKE.

But just because the ratio of the feathered wing-surface when compared with the body of the bird is vastly greater, it follows that the down-stroke (that is to say the haulage work done by the breast-muscles) meets with considerable resistance, offered by the air collected beneath the markedly ample wing-surfaces. Furthermore, the speed, power, and direction of the wing-stroke is so advantageously arranged, that the air beneath the wings is, as it were, 'held up' and becomes more and more compressed, and hence the haulage grows more and more laborious. Finally the wing gains sufficient support to allow the air to act as a fulcrum, and so the body is levered upwards. At last, the mighty haulage machinery is enabled to earn a well-deserved rest. Is it any wonder that these breast-muscles in the bird are so stupendous in size, so massive in area, so powerful in action? I repeat: they are the most marvellous pair of *haulage* machines in the body; working without the aid of a pulley-system. Nay, more; far from being assisted by gravity, they pull down huge structures (the wings) against high and ever-increasing resistance.

PULLEY ACTION OF LESSER BREAST-MUSCLES.

One more pair of wing-muscles call for attention : breast-muscles also, but do you know how to find them on the dead bird ? Carefully cut the great breast-muscles and raise them from the breast-bone, then you will see the very much smaller (*lesser*) breast-muscles, which are also attached to the breast-bone and the humerus. Unlike their greater companions they do not pursue a straight route ; on the contrary they reach their destinations on either humerus by running through an arch ; forming a ring or pulley-like process at the shoulder-joint. (Fig. 8, B.1., f.) The change thus brought about in the direction of the 'pull' results in these muscles acting as elevators of the wings. In other words the up-stroke is helped through the action of these little muscles, the dropping or gravitation of the body rendering further aid. The lesser breast-muscles are quite small because they have light work to achieve, rendered all the easier by the pulley-system.

In a subsequent chapter, when dealing with problems of *flight*, I shall explain more fully the various phases of the wing-strokes, and the manner in which other factors besides muscle-action take part in raising the wings. Meanwhile, the mechanism of perching during sleep, requires to be considered.

Here a problem of great interest arises, which calls for full elucidation in the next chapter.

CHAPTER X.

THE PERCHING MECHANISM.

Mechanical balance of sleeping-bird—Tightening of tendons—Relaxation of muscles during sleep—The falling book and pipe—Attachments of muscles to leg, and their tendons to toes—How tendons are put on the stretch—Bent ankle bends toes—A mischievous school-boy's trick—Mechanics of clasping branch when bird is awake—Action—Muscular — ' Good night, Dicky '—Mechanics of perching when bird is asleep—Sharp bending of knee and ankle—Body-weight—Toes bend and tightly grip perch—Balance of body adjusted by zig-zag props—Muscular movements during sleep—Ducks paddling by one foot—The form and attachments of the *Ambiens* muscle—Absent in perching birds—Action may help birds with feeble clasping-powers to perch—Action negligible in birds which sleep standing—Use to the hunting hawk and racing shore-bird—Extraordinary long, slender tendon—Rapid and precise action—*Ambiens* may act as an accelerator muscle — Swift locomotion on foot — Snapping up prey in the air—Concluding observations—The body-wall composed of muscles, enveloped in membranous wrapper—Machinery within the wall—A closed ' box ' filled with wonderful engines and factories.

NOW we shall turn our attention to a fascinating enquiry ; namely, the nature of the mechanism which allows a bird when asleep on his perch, to maintain his balance so nicely. There is a peculiar interest attached to this form of mechanism, which we shall see cannot depend purely upon muscles contracting actively and continuously all the while the bird sleeps, without the aid of other factors or mechanical contrivances. For we know that during sleep the muscles become relaxed. We may go further and say that sleep is ushered in by the muscles becoming relaxed.

Yes ; 'tis quite true, my friend, you had earnestly intended to finish reading the chapter before going to bed, but, alas ! the book slipped from your grasp before you had turned over the second page ! Perhaps the narrative was dull and an attempt at its perusal rapidly induced sleep, which got the better of you, and in the relaxation of your muscles the grip of your fingers became lost.

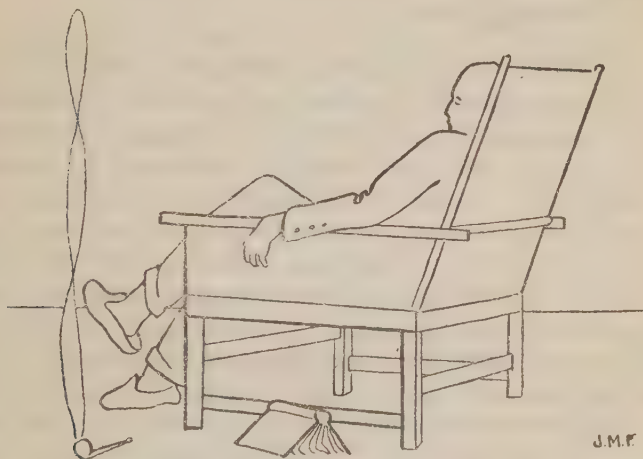


FIG. 29.—THE FALLING BOOK AND PIPE.

" We may likewise fall asleep when taking quite a lively interest in other matters, say, tobacco ! "

But we may likewise fall asleep when taking quite a lively interest in other matters, say, tobacco ! I am partial to the fragrant weed, yet, when sitting at the fire, the pipe has fallen from my mouth more than once ; the muscles of my jaw, as sleep approached, became relaxed. Yet a bird clasps the

perch tightly all night long. How intensely interesting a phenomenon! How can it be done? Let me answer the question directly and explain the mechanism afterwards. *The bird is obliged to clasp his perch tightly owing to a strain being put upon the tendons which are attached to the toes.* This strain, or, so to speak, tightening of the rope, is steady and constant. There will be no difficulty in understanding the mechanism which accounts for the strain when we make a little further dissection.

ATTACHMENTS OF MUSCLES WHICH BEND THE TOES.

You have already detached the fleshy end of a muscle which, when pulled, caused the toes to close up. Put that muscle back in its place and make it secure by a pin. Observe that it takes its origin from an extensive area in the region or neighbourhood of the back of the knee-joint: note particularly that it has some attachment to the lower end of the back of the thigh-bone (femur) as well as to the upper ends of the leg-bones (tibia and fibula). It also obtains a grip upon the ligaments of the knee-joint and knee-cap. Split open the back of the lower part of the leg, the ankle, and the foot (the last-named being the long thin part covered with scales), and you will find a goodly number of long thin tendons springing from this muscle, which can be traced right away down to the toes. Without going into details, you can easily see that tendons are distributed to the individual bones (phalanges) of the toes. The tendons, therefore, are numerous. (Fig. 31, j.)

Strictly speaking, the fleshy mass from which all these tendons arise can be isolated into three parts, forming three muscles. Obviously then the tendons form three sets, which are attached each to their respective phalanges. For all

practical purposes however, the three muscles may be regarded as one, because their action is generally in strict unison. When a bird clasps the branch quite tightly, the tendons are pulled collectively by the shortening or contraction of the fleshy masses of three muscles in concert. When a bird raises one foot off the ground it can bend its toes with or without bending its ankle. When the ankle is straightened out, so that the foot runs in line with the leg, it is evident that *direct haulage*, involving maximum muscular mechanism, is made in bending the toes. When the ankle is sharply bent, the direction of pull becomes angular and requires *less mechanical force*. Observe we are leading up nicely to the point: supposing a bird takes it into his head to bend his ankle to an unusual degree so that the angle between foot and leg is brought down to about 25 degrees. Lo, and behold! What has happened? Look! The toes have closed up. I have just this moment come in from visiting my pet Kestrel in the garden. I left him perched contentedly on one foot with the other lifted up and bent so sharply at the ankle that his clutched claws almost made contact with his leg. Surely you will be in a position to supplement this interesting observation for yourselves when next visiting the Zoological Gardens! (Fig. 27, C.D.)

A MISCHIEVOUS EXPERIMENT!

I am afraid that I was a mischievous boy in many ways.

"Place your finger inside the toes of that dead sparrowhawk," I would say to my incautious friend.

"See for yourself the wide spread of the toes to enable the bird to grasp its prey."

But immediately the toes clutched, and the finger was pinched and pricked by the sharp talons!

"Stop it," entreated my poor playmate; "let go my finger!" (Fig. 30.)

I did immediately as requested, elated at my success in carrying out the experiment. You can guess how the trick was done? First open the toes, then, when the finger is placed within the grasping area, sharply bend the bird's ankle,



FIG. 30.—THE MECHANICAL GRIP BY THE DEAD SPARROW-HAWK'S FOOT.

"Stop it," entreated my poor playmate; "let go my finger!"

and the strain on the tendons will cause the toes to bend and, (in the case of the hawk) to grip like a vice. When a small bird with short legs, such as a chaffinch, or better still, a flycatcher, wishes to scratch its head with one or two extended toes, it lifts its leg and throws it forwards by partly

unbending its knee. The foot can then be raised sufficiently high to allow the toes to reach the head without at the same time the ankle being unduly bent.

THE MECHANISM OF CLASPING THE PERCH.

We are now in a position to understand readily how it comes about that a bird clasps his perch tightly when he bends his ankle sharply. The long tendons which bend the toes take their origin from the fleshy composite muscle high up, i.e., at the region of the knee-joint. This sheaf of long slender cord-like tendons descends along the back of the leg, the ankle-joint, and the foot. These tendons are *crowded together*, utilising every available space. (Fig. 31, j.)

The ankle-joint, acting purely as a hinge, is provided with plane surfaces, over which the whole pack of tendons travel, and then proceed on their journey for another considerable distance, still keeping together along the back of the foot, before they branch off in different directions to reach the respective bones of their toes. In the bird no tendon is permitted to take a short cut at the ankle-joint when entering the foot. The side tracks which occur in our expansive and much more complicated ankle-joints are absent.

At this point it is advisable to link together three facts concerning the state of the tendons when the toes are bent. Let us begin with the case of a bird in which the foot is lifted from the ground, the toes are extended, and the ankle also, so that the foot and leg are in one line. The tendons then are, of course, as firm as usual to the touch, but still can be pressed in against the bone. When the muscle pulls the tendons they become taut, but they are not rendered particularly tense, as the bird has no occasion when he lifts his foot to close up his toes tightly. Next, when a bird, wide awake

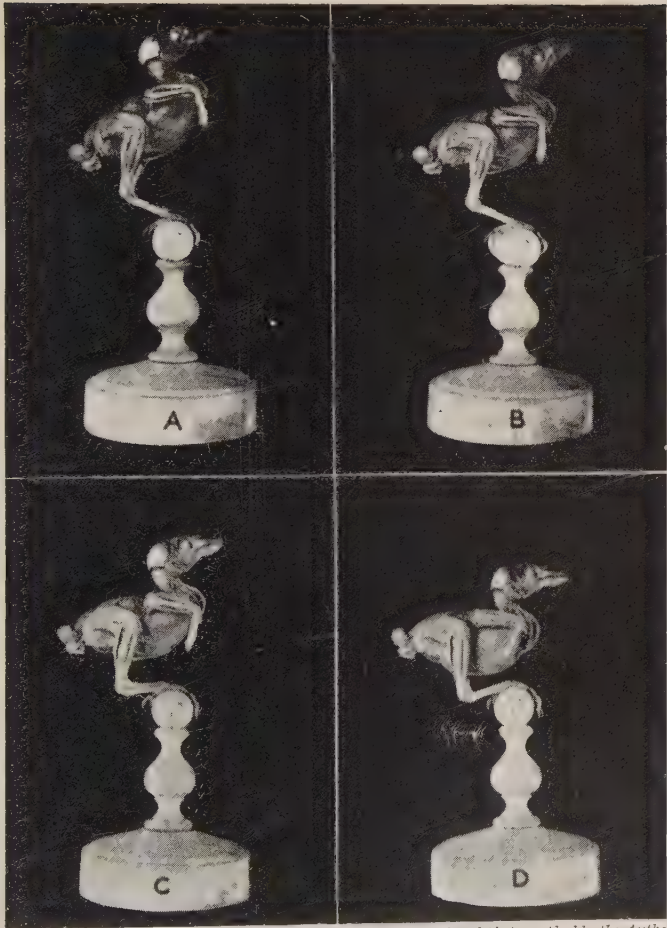
in the day-time, perches, he can tighten his grip whether his ankle be extended or bent, and as he often wants to look tall and gay (especially when singing), he may elect to straighten his feet till they are nearly in line with his legs. But now note, his tendons are rendered more tense by a stronger pull of his muscles, for the perch must be gripped firmly. After finishing his carol he may still wish to grip the perch, but, at the same time to bend his ankle sharply while he stoops to capture an insect creeping on a leaf or twig. The clasping of the toes is still the result of muscular action, that is to say shortening or contraction of the fleshy muscle. Here again the tendons are rendered tense.

We have already learned that when a muscle turns round a corner to reach its insertion, the haulage becomes less laborious, in other words dead-weight is reduced. That is one reason why birds, during the greater part of the time in which they perch, retain the ankle in the bent position. *So far then we have been dealing with active muscular contraction (pure muscular action), in connection with the bending of the toes and clasping of the perch.*

GOOD-NIGHT, 'DICKY.'

Just a moment. Let us go into the next room and wish 'Dicky' Good-Night! For behold! the shadows of evening are creeping up. Look! Our little friend is still tall and sprightly, having just finished his evening lyric; but wait a minute! Yes; he has already lowered himself on his perch to allow his grasping muscles to work with the least labour. Ah! Look again; he has sunk lower, the bend of his ankle is more acute and his little head has disappeared under his wing. He has popped off to sleep. Now why did he assume that lowered attitude? Because in sleep he could no longer

The Perching Mechanism.

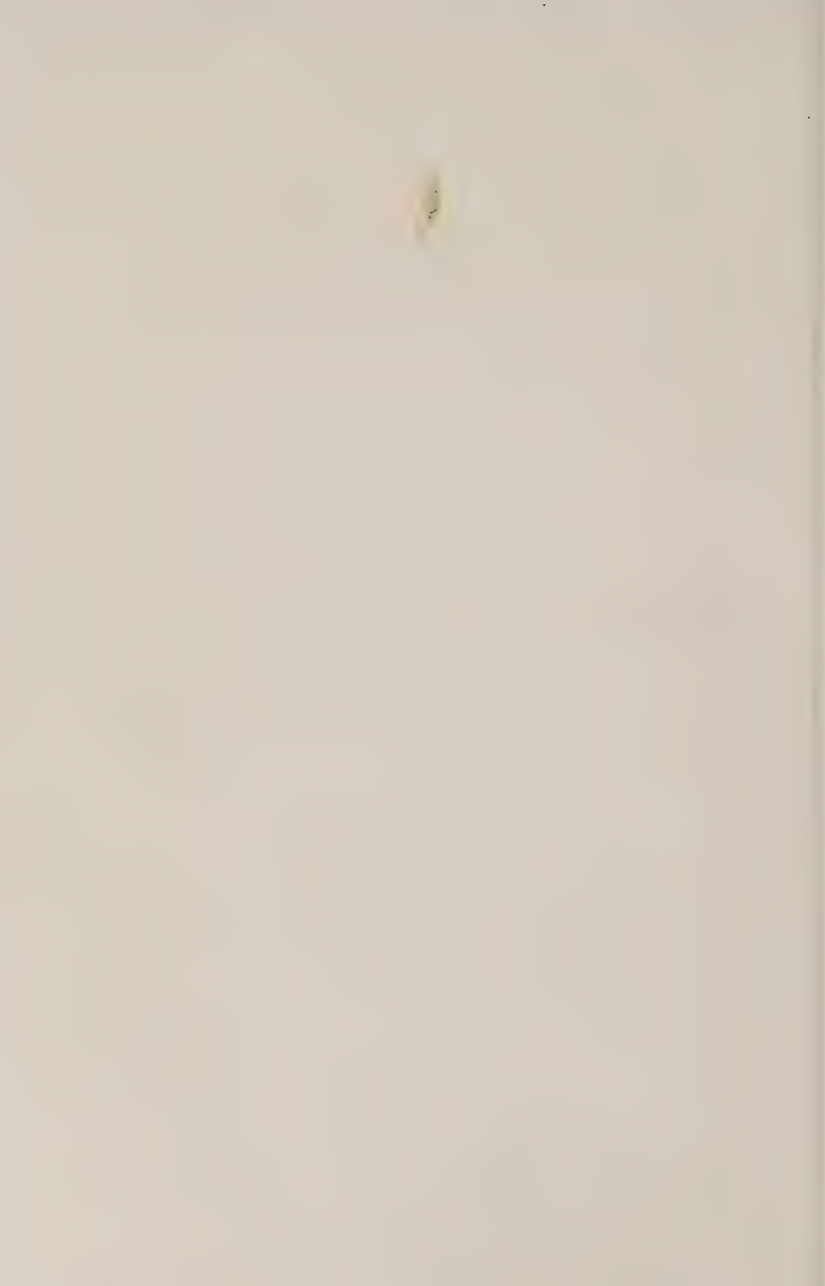


(Specimens prepared and photographed by the Author)

FOUR FIGURES (A.B.C.D.) OF A HOUSE-SPARROW, FROM WHICH THE SKIN HAS BEEN REMOVED TO EXPOSE THE MUSCLES.

"The body is....supported on two zig-zag props, each shaped like the letter Z."

As the bird lowers its body, the Z-shaped props, formed by the bending of the knees and ankles in opposite directions, become more pronounced. Then the strain on the tendons, passing behind the ankle-joint to the toes, becomes increased. Consequently, the toes grip the perch tightly. The overhead weight, formed by the body, ensures the continuous bending of the props during sleep. At the same time the boat-shaped body affords adequate ballast and easy adjustment of the centre of gravity.



depend upon the active shortening of his clasping muscle to pull on the tendons and bend his toes. Indeed in sleep the muscle would have become relaxed. The tendons must be rendered tense in another way. If you could feel them you would find that now they are as tight as a drum. They have been stretched tightly over the projecting heel of the acutely bent ankle, just as the strings of a violin are stretched tightly over the bridge. (PL. XI. A.B.C.D.)

OVERHEAD WEIGHT OF BODY AND ZIZ-ZAG PROPS.

But we ask ; what power is maintaining the strain? *Surely it is an overhead weight*, no less than the *body* of the sleeper ; a weight which is transmitted not only down through the ankle which is thereby kept bent, but also through the knee which likewise is obliged to retain its sharply bent position. *The body is thus supported on two zig-zag props each shaped like the letter Z.* The top stroke represents the thigh running horizontally forwards from the hip-joint to the knee-joint ; the middle slanting stroke represents the leg proper running backwards from the knee-joint to the ankle-joint ; the lower stroke represents the foot running forwards from the ankle-joint to the toes. The weight of the body, on these very efficient double-jointed props, ensures such sharp bending at the knee and ankle, that the tendons of the clasping muscles in their long journey down the back of the leg and feet, become so markedly tense that the toes are fully bent and securely clasped round the perch. The strain is light (although the tendons are kept continuously tense), and so the bird can enjoy a night's sound sleep. Furthermore, the position of the ziz-zag props relative to that of the body, makes it an easy matter for the sleeping-bird to find its

balance, seeing that the centre of gravity falls well within the area of support. (PL. XI. C.D.)

FIXATION OF FOCUS OF CENTRE OF GRAVITY.

It is significant that the rigidity of the bird's body, together with its very characteristic boat-shape and heavy ballast, are factors which specially favour rapid and certain fixation of the centre of gravity. Hence, the bird having once obtained its balance is not likely to lose it during sleep. The marked mobility of our vertebral column makes it a more difficult matter to maintain the centre of gravity without constant fine readjustments. We could not fall sound asleep and remain all night in a standing, motionless position, and at the same time retain our balance.

Having now explained to you the admirable mechanism provided by Nature, which allows the bird to sleep on its perch, it is necessary at the same time to guard ourselves against the dogmatic idea that active muscular action plays no part. Some muscles seem to have an inexhaustible supply of energy. Those attached to our ribs, concerned with the mechanism of respiration, work day and night, but even here the action is rhythmic, allowing periods of labour and rest to alternate in rapid succession. Therefore, while we may dismiss the idea of a clasping muscle of the leg entering into a state of continuous contraction all night long, it is conceivable that the *purely* mechanical strain passively put upon the tendons in the manner above described, may be relieved from time to time during sleep, by muscular action.

SLUMBERING AFLOAT.

As a matter of fact in those birds which slumber on the water, the leg muscles *are* called into action. We have seen ducks

sleeping afloat with one leg raised and the foot protruding from under the wing. At the same time the birds keep moving in a circle by paddling with the other foot. On large sheets of water, especially on the open sea, this measure is seldom adopted, but on small ponds, also larger lakes and estuaries when studded with islands, where the birds might otherwise drift to the bank, it may frequently be observed. Evidently then the sleeping ducks unconsciously bring the muscles of their legs into active use. Some birds, such as the pheasant, the peacock, and the Guinea fowl, roost in trees, although the power of grasping with their toes is feebly-developed. In aquatic birds, which sleep on the ground or on the water, the power is practically lost. The few exceptions hardly call for attention.

THE AMBIENS MUSCLE—A CURIOUS RELIC.

At this stage of our studies, it is expedient to examine a curious muscle called the *ambiens* (Latin: *going round*), which is present in many birds, including the above mentioned. I have taken exception in this case in giving the name of the muscle, and for two good reasons: firstly because it is short, composed of only one word, and easily remembered; secondly, because the possible manner in which the muscle acts offers astonishingly interesting problems. It may be said at the outset that while the *ambiens* undoubtedly is concerned with the movements of some of the toes, its action is of an intermittent rather than prolonged type. Birds which clasp their perch tightly all night during sleep have not an *ambiens* muscle. Its remarkably small size is suggestive of auxiliary rather than independent action. Viewed from the historical stand-point, it is reasonable to suppose that this muscle was more efficient in days gone by, and is now dwindling. It

varies in size considerably in different birds, but is invariably small, so small in some species that it is almost at vanishing point. In a large number of birds, *especially among the higher orders* (e.g., garden-birds), it is completely absent. Before offering any further comments with regard to the work which this muscle may perform, it is necessary to dissect it out and follow its attachments. Above, it takes origin by fleshy fibres from a little projecting spike of bone on the ilium immediately in front of the hip-joint. You remember the ilium is one of the pelvic-bones which unites with two others called respectively the ischium and pubis. From this attachment to the ilium we can trace the muscle as it descends along the *inner* side of the thigh. (Fig. 31, c.) It is remarkable, however, that less than half way down this region, the fleshy part is replaced by a very long, thin, cord-like tendon, which, on reaching the knee, crosses horizontally in front of the joint to the *outer* side. Continuing its course, it curves round to the back of the leg, down which it runs in order to join one of the muscles which bends the toes. In that way it *fuses* with a powerful grasping muscle which, we have already learned, passes round the projecting heel and along the back of the foot to reach the toes. The question arises — Can the ambiens come to the aid of the sleeping-bird? In other words is it customary for those birds which possess the ambiens to bend their toes sharply in order to secure support during sleep? Here be it noticed, that we are looking upon the ambiens as an auxiliary of the powerful muscles which bend the toes. We have just seen that it fuses with one of these muscles, therefore it necessarily acts in concert, not independently. (Fig. 31, c.at.j.)

THE SQUATTING FOWL ASLEEP.

Obviously, when a fowl, in going to roost, squats down on its perch, the slender ambiens tendon will be put on the

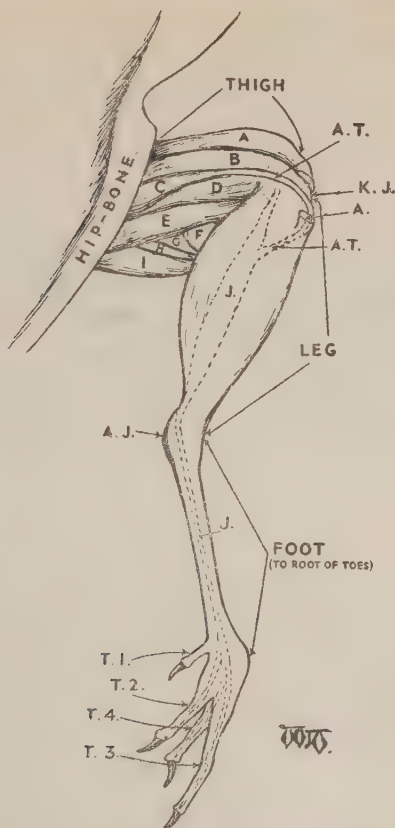


FIG. 31.—HIND-LIMB OF FOWL, INNER VIEW.

Ambiens and other muscles in the thigh exposed.

C.—Ambiens: **A.T.** its slender tendon passing in front of the knee-joint **K.J.**, and under muscle **A**, which is cut to expose it. The Ambiens descends to the back of the leg. Here its tendon **A.T.** is seen joining a long powerful muscle **J**,—in dotted outline,—which descends along the back of the leg, the ankle-joint **A.J.**, and the foot, and splits into three tendons which are attached to the three outer toes, **T2**, **T3**, **T4**. **A** and **B**, passing to the front of the knee, extend the joint. **D** and **E**, passing to the inner side of knee, bring the thigh into close contact with the flank. **F**, **G**, **H**, and **I**, passing to the back of the knee, bend the joint. All these muscles, **A** to **I**, arise from the hip-bone, except **B**, which arises from the thigh-bone, called the Femur. Observe that the three regions of the hind-limb, namely the thigh, the leg, and the foot, are precisely mapped out and labelled.

stretch in passing over the projecting knee and ankle, because both these joints are bent fully and in opposite directions. Consequently the toes would tend to bend, even if we neglect for the moment the action of the main tendons. As a rule the tendons of the hind and fourth toes proceed from muscles unconnected with the ambiens. Hence the latter, in acting even as an auxiliary, could only help in bending the second and third toes. Observe however, that the hind-toe of the fowl is small, and in bending gives no appreciable support; nor would an additional tendon from the ambiens to this toe help matters, even if such were present. Is the ambiens then really serviceable to the pheasant, Guinea-fowl, peacock, and others of this class, all with feet and toes fashioned after the type found in the domestic fowl, and all of which we know show no objection in the least to roosting in trees? It seems it is not. The important point to bear in mind is this: the toes of the above-mentioned species, although capable, of bending are not adapted for clasping the perch tightly. The bending of the second and third toes, aided by the ambiens, would offer no appreciable support to the sleeping-bird. A fowl, when roosting, (unless we endeavour to lift it bodily, much against its will), makes no particular effort to grasp its perch. Its thick, somewhat clumsy, and comparatively short toes put a limitation upon the powers of grip. Indeed a fowl, a pheasant, or a peacock will roost quite contentedly on a branch much too thick to allow the toes to bend other than very slightly.

STANDING UP YET FAST ASLEEP.

In regard to birds which sleep in the standing attitude, (more often than not supporting themselves only on one leg) it should be noticed, in the first place, that the toes, in making

contact with a level surface, must of necessity be straightened, that is to say extended, and, in the second place, the foot is so elevated, here also extended, that it assumes a vertical position and runs in a straight line with the leg. The ambiens obviously would not be put upon the stretch as it passed over the ankle-joint, but it would as it swept past the bent knee-joint. Here then it might possibly act as a *steadying factor* forming quite a useful *stay or binder* in retaining the desired bend of the joint in question. Furthermore, in conjunction with the strong tendon of the muscle which it joins, it would be tightened at the right-angle formed between the lower end of the foot and the roots of the extended toes. Here again, a steadying effect might be established. A bird asleep while standing on one leg, would, in seeking its centre of gravity, welcome any mechanism that fixed its balance during its hours of slumber. But after all, I cannot see my way to attach much importance to the action of the ambiens in this direction. The muscle is present only in some birds which sleep in this posture, for instance the crane and stork, and absent in others, for instance the heron. All these birds are somewhat similarly built, they have long legs, and in their deportment and habits they shew resemblance.

THE AMBIENS AS A HIGH-SPEED AUXILIARY MUSCLE.

In hawks the toes are all well-developed, long, free up to the roots, very moveable, and armed with strong, sharp talons. (Fig. 19, E.) The grasping power of the toes is tremendous. Nevertheless, the grip is not made by the hawk during sleep, but rather for snatching in a flash, the victim which becomes its prey. A hawk sleeps (even when perched on a bough of a tree) with his toes extended, and his feet vertically extended or straightened out in line with his legs, a posture which we

have just seen is adopted by birds which sleep standing on the ground. In hawks the ambiens is present, and it may produce a steadying effect when the bird reposes.

Let us enquire whether the muscle serves any useful purpose when the bird-of-prey is wide awake. We must carefully keep uppermost in mind that the ambiens is, for the most part, composed of an unusually long and slender tendon. The contractions produced by a muscle of this type are exceedingly swift, sudden, precise, and very likely of short duration. Prolonged action would tend to strain this slender delicate machine. I think we may quite tentatively look upon the ambiens as a possible auxiliary muscle which comes into use when exceedingly quick action is the aim.

When a hawk calculates to a nicety, that he is within grabbing-range, he fully extends his leg, opens his toes, and spreads his claws as widely as possible, in order to secure his prey. Then in bending his legs, the swift-acting ambiens hastens the actions of the flexors; the toes, like a flash, are fully bent, the clutch is made, and the bird-of-prey glides down to the nearest quiet nook to satisfy his hunger. Now mark you; without delay he stands with extended feet and toes, high over his prostrate prey: consequently the tendon of the ambiens is once again relieved of its pull.

THE NIMBLE SHORE-BIRDS.

Shore-birds, which can race hither and thither with great speed and precision; which can turn sharply in all directions; and can pull up dead in the quickest and most adroit manner; may find the ambiens helpful by virtue of its sudden power of bending the toes at the moment the extended foot is lifted from the ground. In this way tripping over little obstacles is rendered all the less liable. When the knee and ankle, in the

next place, become bent, the strain put upon the delicate long tendon demands hurried relief ; consequently the leg is once more rapidly extended preparatory to the next step forward. Thus we see that the ambiens may possibly serve the purpose of a useful high-speed auxiliary muscle.

HISTORICAL INTEREST ATTACHED TO THE AMBIENS.

The ambiens is also present in reptiles. Many living species are sluggish, though some when stirred to action present quick, adroit movements. But unlike birds, reptiles for the most part locomote by wriggling their bodies and long tails which keep in touch with the ground, rather than by making sole use of their hind-limbs. The latter are auxiliary propellers in reptiles ; sole, indispensable propellers in birds. How then can we reconcile the same actions of the ambiens in reptiles and in birds ? There seems to be some approach to the solution of this most interesting problem if we constantly bear in mind that many species of extinct reptiles were *bipedal*, that is to say locomoted after the fashion of birds on their hind-limbs. Their gait was in the main, semi-erect, the fore-limbs were short and were not used for purposes of locomotion. Moreover these reptilian creatures were swift and nimble on foot. They might possibly have found the same use for the ambiens which we have surmised may serve wading-birds at the present day. Such a suggestion is of course thrown out in a very tentative manner : it should be regarded as little more than an interesting hypothesis, but most useful in *stimulating thought*. Many of our present-day reptiles may represent sluggish forms derived from long-lost, swift, and nimble ancestors. We are on the safe side in believing that the ambiens acted much more efficiently in birds of past ages than in any living forms of to-day.

Perhaps, notwithstanding what I have said by way of trying to interest you, the ambiens hardly functions at all now, and merely represents but a dwindled remnant of a once well-developed unit in the muscular machinery of those long-lost ancestral forms from which birds and reptiles branched off into such markedly different creatures as we now know them.

A WORD OF ADVICE IN DUE SEASON.

Well, my young friends, we have had two substantial, and I trust profitable discourses on limb-muscles, their form, and position, and the manner in which they act. Do not fail to examine these marvellous haulage machines again and again, in order that you may grow thoroughly familiar with them. Their many-worded technical names can be picked up readily in course of time. Your specimens should be preserved in methylated spirit, or formalin. They should be taken out from time to time and the action of the muscles tested.

Finally, take note that the entire trunk of the bird is covered with muscles, which in turn are everywhere bound together by a fine but firm membranous wrapper which follows the hills and hollows of the muscle covering. This muscular body-wall is, forsooth, a closed box, shutting in and protecting some highly interesting machinery which we shall study in the next chapter.

CHAPTER XI.

THE BODY-CAVITY AND ITS CONTENTS.

A BOX FULL OF WONDERFUL FACTORIES AND ENGINES.

The Bird's body compared to a box—Framework of its walls—Bones, muscles, membranes—The interior a chamber of surprises—Factories and engines—How to open the box—A dissection required—The formation of a lid—Inflation of the air-passages—Removal of the lid—The factory of digestion—Inspection of the machinery undisturbed—The pigeon's huge crop, a storehouse—Variations in the form and development of the crop in different classes of birds—The owl's pellets—Weird fate of a swallowed eel—What is digestion?—The pigeon's gizzard, highly developed—Powerful grinding-machine—Immense muscular strength of walls—We open the machine—A stony chamber—Curious back-teeth—Our Herring-Gull's gizzard—Shell-crusher—Pellets—Birds with feeble gizzards—The doctor's stethoscope and the blast of the mill—The pouch above the gizzard—Proventriculus—Upper chamber of Stomach—Gizzard, lower chamber—Duodenum or upper part of gut—Form and use—Chemicals of two factories—Small pale factory, the Pancreas—Great dark factory, the Liver—The work done—The Heart, the great engine of the body—A marvellous pump—The circulation of the blood—Organs related to lid of box—Gravity and flight—A toy-box with leaden soldiers—A dissection to remove heavy organs—Wonderful surprise—Bubble-like sacks at bottom of box—Marvellous distribution of air-sacks through the body—The inflated wind-pipe—Small scarlet Lungs at bottom of box—Air-sacks aid lungs in respiration—Why air-sacks are scattered over the body—Air-sacks and song—Lark's joyous carol on wings fluttering at several hundred strokes a minute.

WE have just seen that the wall of the bird's body is composed on all sides of muscles and membranes; nor must we forget that the mid-part of the vertebral column, the pelvic bones, the ribs, the coracoids,

the scapulæ, the clavicles, and the breast-bone, form the bony framework. The breast-bone and ribs extend very far back indeed, quite close to the root of the tail, leaving only a very limited area of the front of the body-wall unprotected by a bony cage-work. In Man it is different: quite an extensive part of the front of *our* body-wall lies below *our* ribs and breast-bone. (Figs. 14, 16, st., 1.)

The body-wall encloses on all sides a cavity which affords room and shelter for the vital organs, comprising the wonderful factories and engines of the body. Here then we have a cavity which may aptly be compared to a closed box filled with wonders—a veritable surprise packet! “Let’s pretend” that we have set aside the bodies of the rooks and that I have given you each a pigeon instead. I have selected this bird because its vital organs will prove specially instructive for investigation.

HOW SHALL WE OPEN THE ‘BOX’?

How are we going to open our bird’s body (‘the box’), in order not to disturb any of its contents? Remember, it is most important that we should be afforded the opportunity of inspecting the contents in the first instance, while they lie undisturbed in their natural position.

You know how to expose those tasty little fishes called sardines? Yes; with a suitable tool we cut right round one edge of the tin; then part can be raised like a lid. If the operation has been neatly performed, the little fishes will be seen lying undisturbed and closely packed, heads to tails.

What then shall be the lid of our closed bird’s body? The large breast-bone clothed with its muscles and membranes, that shall form the lid!

'BOX' UPSIDE DOWN.

Observe this important point: when the bird is alive, whether walking or flying, *the box is carried upside down*. The breast-bone or lid looks to the ground, in other words, down-

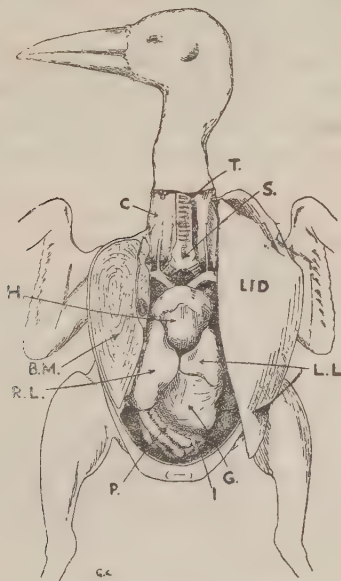


FIG. 32.—THE BIRD'S BODY COMPARED TO A HEAVILY-WEIGHTED BOX.

Heavy Organs exposed.

"How are we going to open our bird's body (the 'box')?.... You know how to expose those tasty little fishes called sardines?..... What then shall be the lid of our closed bird's body?"

C.—Crop. T.—Trachea. S.—Syrinx. H.—Heart. R.L.—Right Lobe of Liver.
L.L.—Left Lobe of Liver. G.—Gizzard. P.—Pancreas. I.—Intestine. B.M.—Breast-Muscle, cut across to allow 'LID' to open.

wards. We shall have more to say on this matter later on, especially with reference to the mechanics and other problems of flight. Now in removing the breast-bone ('lid'), we shall not

require a special strong tool like a tin-opener: a pair of ordinary-sized dissecting scissors will suffice for the purpose. Commence by cutting through the hinder ribs, carry the cut forwards through successive ribs until the strong, thick, buttress-like shoulder-bones (which you will recollect we called the coracoids), are reached. If the scissors be not stout enough to cut through these bones, then snip them neatly across with a pair of bone-pliers. The 'lid' will now nearly come away, but to sever it completely we must cut round the limited ventral area of the body-wall which lies below the ribs.

INFLATION OF AIR-PASSAGES.

Before commencing to remove the 'lid,' that is to say before using the scissors, to cut the ribs, etc., it is advisable to inflate the air-passages by inserting a fine hollow tube into the wind-pipe, and then blowing in air. The wind-pipe next must be tied to prevent the escape of air when the tube (an ordinary blow-pipe will serve the purpose), is withdrawn.

Now let us remove the 'lid' of the bird's body. What do we observe before disturbing the position of any of the contents?

THE CROP OF THE PIGEON.

First of all, the lower end of the extremely capacious *crop*. This organ is very conspicuous. Most of it extends upwards far beyond the 'lid.' Therefore we must dissect the skin from off the neck to see the entire organ. In Man and in other mammals there is only one distended part of the digestive tract, well-known by the name of the *stomach*. But in birds, especially in grain-feeding species with enormous appetites (like our pigeons which we once accused of being horribly greedy), a most capacious storehouse is provided,

in which the food is packed until the stomach is ready to receive it. This storehouse is the crop which we are now inspecting. Except in the case of migrating birds, when they are making long pilgrimages, the crop nearly always contains food-stuffs.

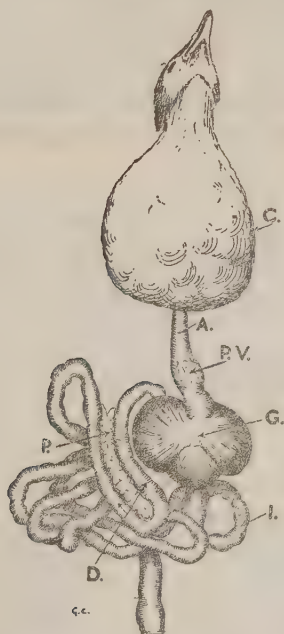


FIG. 33.—DIGESTIVE ORGANS OF PIGEON.

"It is far better to say, 'I am really ashamed of my pets for being so greedy,' than merely to scatter the corn and take no notice of their table-manners."

C.—Crop (immense size). A.—Æsophagus (gullet). P.V.—Proventriculus. G.—Gizzard.
D.—Duodenum. P.—Pancreas. I.—Intestine.

When a bird, for instance, a pigeon, fills his crop to the brim with grain, acorns, beech-nuts, or other tough material which subsequently requires energetic digestive treatment by

the juices of the stomach and other factories, he nevertheless retains his energies unimpaired, and will fly hither and thither at high speed. Very different is the case in most reptiles. These creatures become torpid, often for several days on end, after partaking of a hearty meal. Our common grass-snake offers a familiar example. Fowls, pigeons, and other birds, which feed upon various hard fruits, possess well-developed crops in which the food undergoes some softening, through contact with moisture and warmth, preparatory to digestion. (Fig. 33.c., Fig. 34.)

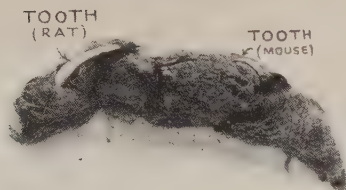
THE CROP OF PREDATORY BIRDS.

Birds of prey also have very definitely-shaped crops of considerable size, because when their quarry is large (and usually such is the case), they gorge themselves to such an extent that the stomach could not possibly afford space enough to receive it all at the one time. The crop of predatory birds, (especially of owls), by the contractions of its walls packs and stores those indigestible fragments of fur, feathers, and bones, which are in the first place swallowed voraciously, and for the most part piece-meal, with the rest of the carcass. The crop completes the work of the gizzard in moulding these fragments into tidy little bundles, called *pellets*: these are ejected by the mouth before another meal is commenced. (PL. XII. A.B.C.)

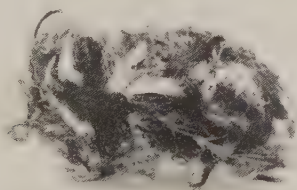
THE CROP OF FISH-EATING BIRDS.

In purely fish-eating birds the crop is very small; indeed it may be indistinguishable, in which case the *gullet* leads straight into the stomach without any intervening expansion. Remember that the gullet in an animal is the first part of the alimentary or food-tube: it begins at the back of the mouth, and in mammals leads directly into the stomach. Mammals there-

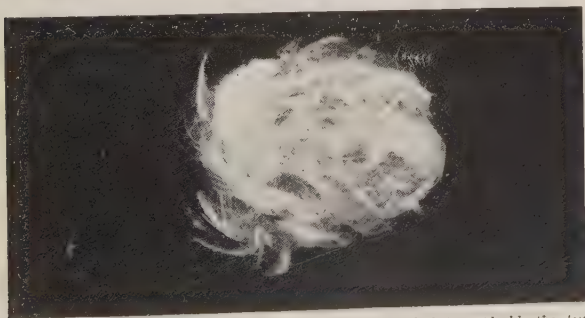
The Crop of Predatory Birds.



A.—Composed of hairs, in which are partly embedded an incisor tooth of a Rat, and another of a Mouse.



B.—Composed of fragments of bone, and black and white feathers of a Puffin.



(Specimens collected and photographed by the Author)

C.—Composed of white feathers of a Kittiwake Gull.

THREE PELLETS OF A PEREGRINE FALCON, SHEWING THEIR COMPOSITION.

"The crop of predatory birds....packs and stores....indigestible fragments of fur, feathers, and bones....tidy little bundles, called pellets....are ejected by the mouth before another meal is commenced."

fore, as a class, are not provided with a crop. In those sea-birds which swallow large and sometimes very elongated fishes, such as eels, the gullet is very capacious and highly expansile. In the Pelican the mouth leads into a tremendous potential pouch which, when full of food or water, always appears as a remarkably roomy bag, directly continuous with the floor of the mouth. In the Cormorant and other sea-birds, which are capable of swallowing instantly large fish, the pouch-like expansion becomes quite evident when the prey is being engulfed. Close inspection will reveal to us the fact that the entire gullet right down to the small dilatation representing the crop (or to the stomach if the crop be absent) undergoes marked expansion, so that the fish when seized and introduced into the mouth head-foremost, is jerked almost straight down into the stomach.

HALF-DIGESTED CONGER-EEL WRIGGLES ITS TAIL.

I have known of more than one instance in which a cormorant was killed in the act of swallowing a large conger-eel ; the head of the victim had reached the stomach and was already shewing signs of digestion while, still sticking out of the bird's mouth, was the tail-end of the fish wriggling frantically !

WHAT IS DIGESTION ?

You ask what I mean by digestion ? Here is the answer in very simple language. When certain kinds of substances, notably the muscles of animals (of course including fishes), reach the stomach, a peculiar pale fluid known as *gastric-juice*, containing powerful chemicals, commences to dissolve the fleshy food and convert it into liquid, just as water will

dissolve sugar. Next the dissolved flesh, in fluid form, enters myriads of little blood-vessels and is absorbed into the blood-stream which, as it flows, takes up the nourishment and distributes it to the body.

THE STOMACH OF THE PIGEON.

We must now turn our attention to the stomach of our pigeons. Between the gizzard and the crop we see another saccular or dilated part of the digestive tube. This and the gizzard taken together correspond to our single stomach. In other words a bird has a stomach composed of two distinct compartments.

THE PROVENTRICULUS.

The upper compartment corresponds more closely to our stomach because it possesses great powers of digesting certain food-stuffs. This compartment has not received as yet a nice, easily remembered name, so we shall have to adopt the scientific term, *proventriculus*.

This sac is small, thin-walled, and pale in colour, moreover, it is not very noticeable. (Fig. 33, pv., Fig. 34.)

THE GIZZARD.

Now look at the hinder compartment of the stomach (the appearance of which doubtless you are already very familiar with in a fowl), namely, the gizzard. This organ is very noticeable. (Figs. 32, 33, g., Fig. 34.)

Observe the remarkable size it reaches in the pigeon; this is also the case in the fowl, and allied birds, which live upon corn and other hard, dry fruits. Note the rich reddish-brown colour of the wall of this organ, in the centre of which we see a silvery-looking glistening tendon. If we were to

turn the gizzard round, the tendon would be seen also on the other side. What then is the composition of this wall ? It is muscle, exceedingly dense and powerful. Press tightly between finger and thumb and feel how hard and resisting it is to the sense of touch. The gizzard is a very powerful muscular organ ; by its active contractions it grinds the hard undigested food-stuffs which soon pass down into it from the proventriculus. Much of this material generally consists of tough hazel-nuts, beech-nuts, acorns, or corn. But a big surprise still awaits our investigations. Take hold of the scissors and slit open the gizzard. Look at the quantities of little stones which are lying about on the rough, yellowish, wrinkled inner wall of the organ ! See ; they are intermingled with half-crushed grains of wheat and oats ! The little stones have been purposely swallowed by the bird to render the grinding mechanism of the gizzard thoroughly efficient. No doubt you have noticed fowls in the hen-run, picking up grit and pebbles from time to time.

The grinding action of a full gizzard, charged with food-stuffs and well supplied with pebbles and grit, may actually be heard by placing one's ear against the upper part of the breast of a domestic fowl. I have heard the mill grinding also in a pigeon, though perhaps a little less distinctly.

DOCTOR'S STETHOSCOPE AND BLAST OF THE 'MILL.'

By listening through a doctor's stethoscope (you probably have seen this instrument being used on sick people), the noise of the grinding can be very distinctly heard when the 'mill' is in full blast. Remember I mentioned in the first chapter that birds have no teeth corresponding to our molars or back-teeth which grind and roll the food in the mouth and thus prepare it for digestion. Therefore

we must look upon the stones in the gizzard as playing the part of a bird's grinding or 'back-teeth.' By the churning action of the immensely strong, thick, muscular wall, these little stones and grit are set in motion, thereby grinding and 'chewing' the hard corn, etc., into quite a soft pulp, which in turn passes downwards into the fore-part of the *intestine* where digestive processes are completed. I also referred in the first chapter to the fact that some birds which live mainly upon soft, juicy, vegetable and animal food (which of course requires no chewing), have feebly-developed gizzards. Such birds can swallow their food and digest it without the use of grinding-stones, just as we can swallow bread, softened in milk without using our back-teeth. In purely fish-eating birds, where digestion is almost completed in the proventriculus, the gizzard is thin-walled and weak, although variable in size.

GIZZARD OF OUR HERRING-GULL.

Now let us remove the 'lid' of our Herring-Gull's 'box' and examine the gizzard. It is quite well-developed, muscular, and a fair size. Yet the Herring-Gull is a fish-eater: true; but he also eats many hard stuffs besides fish, for instance, crayfish, lobsters, crabs, mussels, cockles, and other *molluscs* (shell-fish), the shells of which all require to be crushed. It is most interesting to note that gulls swallow stout fragments of shell as well as stones, in order to enable their 'back-teeth' to crush the smaller and thinner shells of the living shell-fish which they eat. Note also that in our Herring-Gull (when I skin the neck), the gullet is spacious, very elastic, and leads almost directly into the proventriculus, seeing that the crop is so feebly-developed. The proventriculus, itself, like the gullet, is spacious and expansile.

THE INTESTINAL TUBE, DUODENUM, AND PANCREAS.

Continue your observations on the Pigeon while I make use of the Herring-Gull, because those organs, which may be studied in the remaining pages of this chapter, present no special features in one bird more than another. Leading out from the other end of the gizzard we observe the intestinal tube, elongated and coiled, therefore very easily recognised, not only in birds but also in every class of vertebrate animal. The upper part of this tube (which immediately succeeds the gizzard), furnishes chemicals which, on the one hand digest special food-stuffs, which pass through both parts of the stomach undigested, and on the other hand, food-stuffs already submitted to the action of the gastric-juice, and now in this tube rendered completely soluble. It is here also that the digestion of fats and starchy foods is carried out, through the co-operation of the juices of the *liver* (*bile*), and of another organ called the *pancreas*. The latter is whitish-coloured, and we might readily pass it by were we not to look carefully at the distinct U-shaped loop which the first part of the intestine presents. This loop is called the *duodenum*, and we see that it almost surrounds the pancreas, which is a rather thin, flat, though irregular-shaped organ ; indeed its contour is moulded chiefly by the duodenal loop. Observe that the surface of this pale-coloured organ, owing to the presence of numerous little lobes, is rough and irregular, like stiff porridge : hence we call it lobulated. The pancreas and the liver manufacture juices which are conveyed by their ducts into the duodenum, and there, as already mentioned, can exercise digestive powers. (Fig. 32, i.p., Figs. 33, 34, d., p.)

THE LIVER.

Next observe a much larger and far more conspicuous reddish-brown organ, massive in shape, but very pliant in

texture: observe that it is situated in front of both parts of the stomach, that is to say nearer to the head of the bird.

What is this organ? The liver; it is easily recognised. Have you not often seen it when put into the fold of the skewered wing of the fowl prepared for dinner, the gizzard occupying the opposite side? The liver is composed of two distinct lobes, a right and a left: it differs in shape from the human liver, but as it serves the same purpose, and presents no other structural peculiarities, there is no necessity therefore to give it further consideration. As already indicated, the duct of this organ conveys the bile into the duodenum, and the bile has its important work to do in connection with digestion. (Fig. 32, rl., ll., Fig. 34.)

THE HEART.

Above the liver, that is to say nearer to the head of the bird, we observe the *heart*,—truly the body's supreme vital engine; it is longer and more pointed proportionately than in mammals, and it is placed in the mid-line of the bird's body. The lower and narrower part of our heart, often called the *apex*, inclines over to the left side. The avian heart is certainly a very strong muscular pump, containing four chambers. Two of these are called *auricles* from their fancied resemblance to ears, and two are called *ventricles*. Impure blood from the body is carried by veins into the right auricle, thence it is pumped into the right ventricle and from this chamber into the lungs,—and their extensions, the air-sacks,—for purification. The purified blood is next returned by veins which open into the left auricle, and thence it is pumped into the left ventricle, which chamber in turn propels the blood all over the body. Having nourished the body, the blood again growing impure, is returned to the right auricle

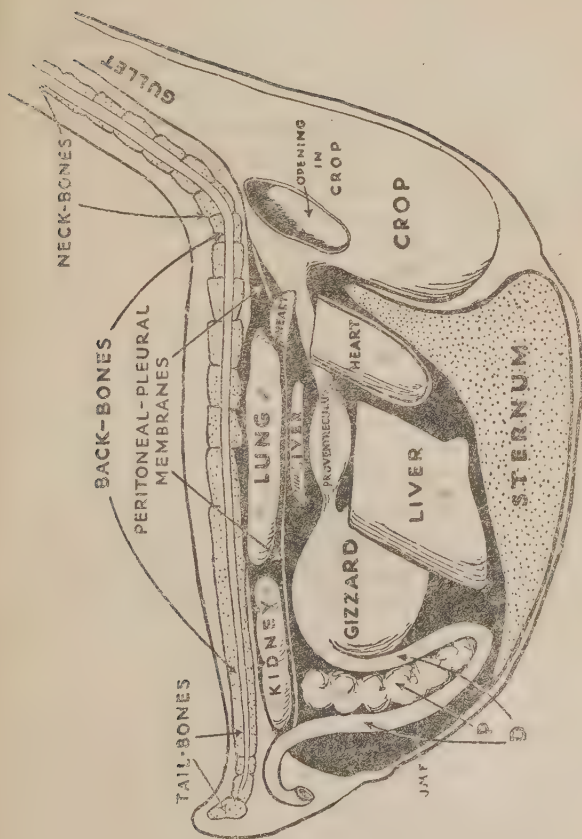


FIG. 34.—THE 'BOX' IN VERTICAL SECTION.

Light and Heavy Organs exposed.

"All these various heavy organs.....are in contact with the inner or deep surface of the 'lid' of our 'box.'.....We clearly see.....they serve the purpose of ballast for the boat-shaped bird's body in flight."

Observe:—The peritoneal-pleural membrane 'strapping' the kidney and lung (light-weight organs), to the bottom of the 'box.'

to repeat the circulatory cycle. The so-called 'beat' of the heart, which can be heard through the chest-wall, is really the sound of the pumping of the auricles and ventricles. The design of the avian heart in structure and use, follows that of the human heart. Here, all we need add is, that in the former it is particularly strong because it has strenuous work to carry out in driving the rapidly-flowing blood through the lungs, air-sacks, and rest of the body. Recollect that the blood is considerably hotter and the circulation faster than in Man and other mammals. (Fig. 32.h., Fig. 34.)

HEAVY ORGANS IMPINGE UPON 'LID.'

Here it is expedient to take notice of a very important point, namely: that all these various heavy organs which we have been examining, are in contact with the inner or deep surface of the 'lid' of our 'box'; in other words with the inner surface of the breast-bone. Observe, most carefully, when a bird is flying, its breast-bone (do not forget it corresponds to the 'lid' of the 'box') looks downwards towards the earth. Hence the heavy organs which we have now studied, tend to gravitate and come into closer relationship with the deep surface of the sternum or breast-bone. (Fig. 32. ['lid'] Fig. 34. [sternum].)

THE BOX OF TOYS UPSIDE DOWN.

It is as though we had a box not quite filled with toys. Place the box right side up and naturally the toys will rest on the bottom. Turn the box upside down and naturally the toys will come in contact with the inner or deep surface of the lid. If these toys be heavy (*say a collection of leaden soldiers*), and if at the same time the lid be somewhat rounded off so that the box can rock or roll when placed on the level ground, it is quite obvious that it will not topple over

when in this position, because it behaves like a carefully-weighted boat, rocking about on the water. We may safely proceed a step further by way of our illustration: supposing that a few more toys (*exceedingly light in weight*), be covered by a very thin sheet of paper, gummed by its edges to the bottom of the box, it is clear that when the box is turned upside down, the light toys cannot alter their position, they cannot gravitate or drop on to the deep surface of the lid, nor, by virtue of their very light weight, can they overthrow, nay more, even disturb the balance of the inverted box, despite the fact that they are lodged in the opposite part of the cavity.

HEAVY ORGANS PROVIDE BALLAST.

Having examined the heavy organs, we clearly see that on account of their very intimate relation with the deeply-keeled breast-bone, they serve the purpose of *ballast* for the boat-shaped bird's body in flight.

Recollect, I referred to this point in the second chapter by drawing your attention to the fact that in order to lessen the risk of a boat being capsized, its keel must be weighted, either by attaching heavy metal to it such as lead, or by filling the hollow of the inside of the boat (called the 'hold') with heavy material, in order to form ballast. Then I stressed the point that the attachments of the great breast-muscles of the bird to the under-surface and keel of the breast-bone, together with the weight of the heavy organs which impinge against its deep or upper surface, serve the same purpose in the case of the avian boat-shaped body. (Figs. 32, 34.)

OPERATION TO REMOVE HEAVY ORGANS.

The time, however, has now arrived when we should remove all these heavy organs which impinged upon the

inner surface of the breast-bone, that is to say upon the 'lid' of the 'box,' otherwise, of the bird's body.

Take your scissors and carefully snip through the gullet and also the lower end of the intestine, and then the crop,

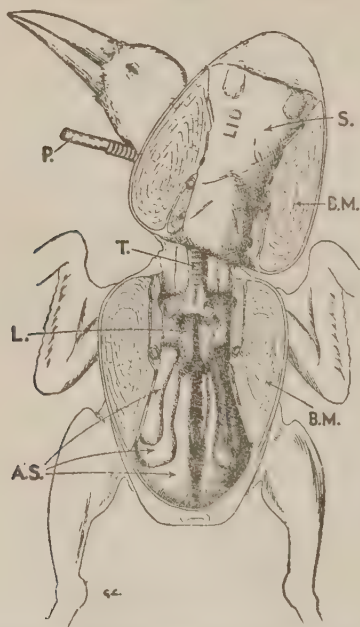


FIG. 35.—THE BIRD'S BODY COMPARED TO A LIGHTLY-WEIGHTED BOX.

Light-weight Organs exposed.

"Look how nicely 'the blebs' are distended....How were they filled?..... we tied the wind-pipe, so that the air we drove into it could not escape.

P.—Pipe (in trachea). T.—Trachea. L.—Lung (right). A.S.—Air-sacks. S.—Sternum. ('LID.') B.M.—Breast-muscle cut across to allow 'LID' to open.

stomach (proventriculus and gizzard), liver, pancreas, and the intestinal tube will, when detached from the membranes which connect them to the body-wall, all come away without

difficulty. The heart also can be removed if the blood-vessels which spring from it be cut across. We must carry out our dissections most cautiously lest the *light-weight* underlying organs be injured. Supposing that we have been successful in our dissection, we find ourselves rewarded with a wonderfully surprising spectacle.

BUBBLE-LIKE AIR-SACKS.

'Blebs' or bubble-like transparent *sacks*, of all sizes and shapes, appear everywhere, not only occupying the bottom of our 'box' but also wandering far up into the neck, under the great breast-muscles, burrowing between other muscles, and, if time permitted us to dissect further, we would soon discover them extending under the surface of the skin, and even entering the hollow chambers in many of the bones. (Fig. 35. as., PL. XIII.)

Look how nicely the 'blebs' are distended. What do you think they contain? Yes; air to be sure. How were they filled out with air to so great an extent? Remember a necessary operation which we performed before taking the 'lid' off our 'box'? We tied the wind-pipe, so that the air we drove into it could not escape. It was carried through passages leading into the lungs and thither into the membranous sacks. The latter, great and small, are receptacles for air which freely communicates with the lungs. When a bird breathes through its wind-pipe not only the lungs but also every *air-sack* is filled with air. But why are these thousands of reservoirs present? (Fig. 35, p., 1., as.)

THE LUNGS.

Look at the *lungs*! They lie close against the bird's back,—remember the bottom of our 'box',—and under

the area where the heart and upper part of the liver were situated. The lungs cannot possibly be mistaken on account of their bright scarlet colour and spongy feel. Note that these organs are *remarkably small* (on comparing the lungs of a mammal you will appreciate this fact all the more readily), and *inelastic*. (Figs. 34, 35, 36, 43, A.B. PL. XV. A.B.)

On expanding the chest (or what is popularly spoken of as drawing in the breath), our lungs become very markedly distended, and when the chest contracts and the air is expelled, our lungs are compressed into a considerably smaller size. But the avian lungs remain almost constant in size in both phases of respiration, which means that they are not able to do the work of purifying the blood without some further help. Here then the air-sacks come to the rescue, the combination providing a very effective breathing-machine.

RESPIRATORY FUNCTION OF AIR-SACKS.

A bird normally moves through the air,—and some species through the water and on land,—with great rapidity. Hence breathing is fast, as it becomes with us when we take active exercise. Consequently, a bird requires plenty of fresh air to fill its many spacious sacks. The sacks, in being scattered, impart buoyancy to the entire body. At the same time the bird's breathing-machine is kept clear of the effects of the mighty down-stroke of the wing. If the air-sacks were all collected together into the cavity of the chest and closely massed, so as to form two very large lungs (a right and a left), there is no doubt that they would feel the ill-effects of the compression of the air and of the mighty down-stroke beat of the wing against the chest-wall in flight. Of course, the presence of all these air-sacks makes the entire body lighter than if they were absent: nevertheless, as we shall

see on a future occasion, they only play quite a secondary part in the mechanism of flight.

VOCAL FUNCTION OF AIR-SACKS.

I am of the opinion that the air-sacks lend their aid in the production of voice, especially in birds which have highly-developed powers of singing. Just think of the great draught of air a bird could expel from its sacks into its air-passages at the root of the neck, where the vocal membranes would be set rapidly vibrating.

Here it is highly interesting to observe that there are some birds which can produce quaint low, hollow, rumbling noises,—often not by any means unmusical,—by inflating large external air-sacks, which then appear as two great ‘ear-drums’ hanging from either side of the face. Each is directly continuous, by means of an opening, with the wind-pipe, through which, of course, they can be inflated.

We must now adjourn our studies of these wonderful air-sacks. In the next chapter we shall examine them again in conjunction with our studies and dissections of the light-weight organs. Remember that no other animals have their bodies fully permeated with the atmosphere like birds. This is as we should expect, for the mechanism of their breathing has undergone wonderful development.

Let me finish this chapter by taking the well-known and delightful illustration of a lark, rising high on wings which flutter at several hundred strokes a minute! All the while he carols joyously, with ease and marvellous flexibility of voice. Let you or me run up a short hill, and then try and sing! Are we not at once knocked out of breath?

LECTURE 7.

CHAPTER XII.

FILTERS AND VENTILATORS.

THE MACHINERY PACKED IN THE BOTTOM OF THE 'BOX.'

Heavy organs removed—Light-weight organs 'strapped' to bottom of 'box'—Further examination of lungs and air-sacks—Kidneys, oblong in shape, very long, and large—Term 'kidney-shape,' referable to form of mammalian kidney—Kidney-bean, etc.—Large abdominal air-sack in front of kidney—Kidneys 'strapped' to back wall of abdominal cavity—Peritoneum—Air-sacks and peritoneum cut away—Kidneys excavated from their 'beds'—Deep surface of kidneys sculptured—Irregular bony-floor—Marked hills and hollows—Lungs 'strapped' to back wall of abdominal cavity—Pleura—Air-sacks and pleura cut away—Lungs excavated from their 'beds'—Deep surface of lungs sculptured—Irregular bony-floor—Ribs leave impressions on lungs—Lungs in Man clothed by pleura; very elastic and free to expand in chest-cavity—Avian lungs inelastic and capable of little expansion—Air-sacks act as compensatory organs—Why kidneys are so large—Powerful filters—Work done—Discharge of waste fluids from the body, very frequent—In Man, skin, lungs, and kidneys, help to carry off superfluous heat—Sweat-glands absent, and lungs small in birds—Kidneys and air-sacks help to dissipate superfluous heat from the body—Air-sacks largely concerned with regulation of body-temperature—The box of toys—Feather-weight contents gummed to bottom and cannot fall out, be displaced, or upset balance of inverted box—Light-weight organs, viz., lungs, air-sacks, and kidneys, 'strapped' to bottom of body-cavity, and cannot fall out, be dislodged, or interfere with balance of bird's body during flight.

WE must now proceed apace with our anatomical studies. "Let's pretend" that once more we are all assembled round the table. Your specimens are really in a state of splendid preservation. I congratulate you in losing no time in removing them from their pickling jars and making them ready for further dissection. We notice, in the first place, that they are very light in weight. That is because we have now completely removed the heavy organs. In other words, our 'box,' has been emptied, in a great measure, of its contents. Observe that those organs which are still *in situ* are in close contact with the bottom of the 'box,' that is to say with the deep or inner surface of the back-bone. What then are these organs? In the first place we at once recognise the *lungs*: we saw them on a previous occasion. They have now lost their delicate pinkish tint, due to soaking in spirit. Some of the air-sacks, closely applied to the bottom of the 'box,' are also plainly visible. Behind the lungs (nearer to the tail) and also lying close to the back-bone, two elongated, dark-coloured masses can be seen. These are the *kidneys*. I doubt if you would have recognised them immediately. Why? Because avian kidneys are not '*kidney-shaped*!' It might seem at first sight as though we were playing with words, but no: it must not be forgotten that it is customary, for descriptive purposes, to regard the shape of the mammalian kidney as the type. The human kidney and that of a dog, cat, rabbit, sheep, and of other mammals, is so characteristic, that it is convenient, in indicating its form, to say straight away, '*kidney-shaped*.' Hence it has come about that this expression serves the useful purpose of describing the shape of many common objects. Take for instance the well known term '*kidney-bean*,' which denotes a bean shaped like a mammalian kidney.

It might be technically more correct to speak of the 'kidney-shaped' bean. You may know the gorgeous 'eye'-spots which adorn the very long and beautiful tail-covert feathers of the peacock. In these decorative plumes the central very dark blue patches are 'kidney-shaped.'

As in mammals, so in birds there are two kidneys. These organs are dark reddish-brown in colour, and rather firm

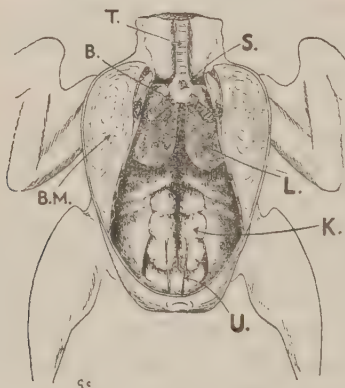


FIG. 36.—THE BIRD'S BODY COMPARED TO A LIGHTLY-WEIGHTED BOX.

Light-weight Organs exposed. Air-Sacks cut away.

"What prevented these organs from falling out? Surely they were 'strapped' to the bottom of the 'box' by membranes."

T.—Trachea. B.—Bronchus. S.—Syrinx. L.—Lung. K.—Kidney. U.—Ureter. B.M.—Breast-muscle, cut across to allow 'L.M.' to come away.

(In this sketch the 'L.M.' is not figured.)

in consistency. Their front surfaces are on the whole flat, though, on looking closely, we detect slight hills and hollows, indicating the presence of lobes. (Figs. 34, 36, k., 37, b.)

FORM OF AVIAN KIDNEYS.

In your pigeon each kidney is very large, long, and four-sided in contour, and extends from the posterior end of the

lungs almost to the root of the tail. Spread over the front of each organ we observe a remarkably large air-sack. This is often spoken of as the *posterior abdominal air-sack*. It is transparent and therefore allows us to see the dark brownish kidney shining through its walls. With your scissors snip the wall of the air-sack: note, it collapses when the air escapes; next peel away very gently the wall of the sack, and the front of the kidney then comes plainly into the field of view. Repeat the dissection upon the other side, in order that both organs may be fully displayed. Now cut away the thin membrane called *peritoneum* (Fig.34.) and then raise each kidney carefully from its 'bed' with the handle of the knife. Immediately we observe how very intimately indeed they are moulded against the back-bone (here the sacral region of the vertebral column), consequently, the various inequalities of the bony floor are stamped upon their back surfaces. Indeed we may go further and say that these surfaces have been very distinctly sculptured by the impressions of the various bony prominences of the sacral-vertebræ. At this point it is expedient also to excavate each lung from its 'bed.' Carry out the operation as before, when dealing with the kidneys. It will be necessary to remove the overlying air-sacks, and the thin membrane called *pleura*. (Fig.34.)

PLEURAL AND PERITONETAL MEMBRANES.

Observe again the very intimate manner in which the lungs are impacted against, not only the back-bone, but also the posterior parts of the ribs. The latter, together with the inequalities of the vertebræ, have left their impressions deeply sculptured upon the back of the lungs. The organs are held in position, or so to speak, 'strapped down' to the back-bone, by the pleural membrane, which, we noted, clothes them

in front. (Fig. 34.) Our lungs, which are quite enveloped by the pleural membrane, lie freely in the chest-cavity (except where they are continuous with large blood-vessels and air-tubes, which form their root), and therefore can expand to a great extent when well inflated with air. This is not the case in birds; hence the necessity of air-sacks. The avian kidneys are also 'strapped' in front to the back-bone by the membrane, already called peritoneum. (Fig. 34.) The great size of these

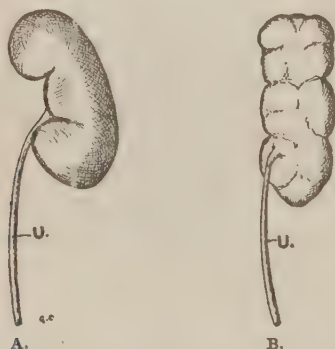


FIG. 37.—KIDNEY OF (A) MAN AND (B) BIRD.

"I doubt if you would have recognised them immediately. Why? Because avian kidneys are not 'kidney-shaped'!"

U.—Ureter.

organs is associated with their active duties. What sort of machines, then, are the kidneys? To put it shortly they are most powerful filters.

HOW THE KIDNEYS DO THEIR WORK.

When the blood is flowing in its tubes (arteries and veins), thousands of very minute branches pass through the kidneys, and then, wonderful to relate, the organs extract from the

blood the waste fluid-material, which from time to time had found its way into the blood-stream. From each kidney a drain-pipe called the *ureter* takes away this waste material which passes from the body in the form of fluid, and if it were not eliminated the animal would sicken and indeed in time be poisoned. The waste material comes from part of the food we eat and the fluids we drink. (Fig.38.B.u.) All food and drink throw off waste material as well as provide nourishment, but when we take a meal we are not aware which are the good parts of the food or drink and which exactly the bad. But the wonderful chemicals in the stomach, the duodenum, the liver, and the pancreas, (which I mentioned in a previous chapter) can separate out the nourishment from the waste material; and when the latter is in fluid form it is seized upon and extracted by the kidneys.

The passage of this waste material also helps to relieve the body of some superfluous heat. Now, there are two other organs which help *us* to keep cool when we get rid of fluids, namely, the skin and the lungs.

HUMAN AND AVIAN SKIN.

We know that *our* skin becomes moist when we take violent exercise, or indeed on a very hot day without taking any exercise. Our skin is studded with innumerable pores, through which the warm water escapes. A bird has no pores in its skin, and consequently extra duties fall upon the kidneys: hence they are relatively larger in size than in most mammals. Here it is very interesting to observe that in some mammals such as whales, and in some cold-blooded creatures such as reptiles (where there is no machinery in the skin to collect and release the water), the kidneys are also relatively large. But a more important reason why birds

possess such large kidneys is because the filtering processes are so remarkably frequent and active. We have learned that all the vital organs in the bird discharge their duties more actively than in the mammal. The heart pumps the hotter blood of the bird more quickly, food is taken more often, and digestion is more rapid: hence waste products are discharged into the blood more frequently. These products, rushing through the rapidly-flowing blood-stream, must be filtered very speedily; otherwise the bird would soon sicken and die.

We have now the second point to consider. *The lungs* as well as the kidneys (and in mammals the skin), aid not only in cleansing the body of fluid impurities, but they also help to regulate the body-temperature by getting rid of superfluous heat.

In birds, obviously, the air-sacks come to the rescue of the very small lungs.

THE WINDOW-PANES AND A FROSTY MORNING.

“Let’s pretend” that it is a clear, bright, frosty morning and that we all start to breathe on the cold window-panes of this gigantic room in which we have assembled. What do we see? A great stretch of film, masking the transparency of the glass. What is the composition of this film? It is water in partnership with the atmosphere, in that extremely finely divided state called *aqueous vapour*. This moisture (for to be technically correct one cannot call it water until it condenses) is taken from the blood by the lungs and expelled in the outgoing breath. This is a good thing, because gaseous breath is not wholesome. Many of you are doubtless familiar with *carbonic acid gas*: the air we breathe out, that is to say, expel from our lungs, contains that poisonous material mixed

with water. Rub the film on the window-glass. It actually wets the point of the finger: it has, by condensing on the cold surface, become visible in the form of water. This condensing of the breath on a cold surface is all the more readily understood if we remember that when the breath leaves the nostrils, or mouth, or even both (for we often breathe partly through our mouth and partly through our nose) it is warm: if it were hotter it would condense instantly. Just hold a cold plate in front of the spout of a steaming kettle and observe the manner in which we can collect drops of water in a moment!

REGULATION OF BODY-TEMPERATURE.

How then do we get rid of superfluous heat from our body? Partly by the warm fluids which pass out from our kidneys and through the minute pores of our skin, and partly by the warm vapour-gas which passes out from our lungs along our wind-pipe. The latter, when it is exhaled, is of course atmospheric air, *deprived of some of its oxygen* which the lungs used up to nourish the body, and *charged with carbonic acid gas* which the lungs gave out as waste material. This '*lung-atmosphere*' is hot! Why? Because it came into relation with the hot blood flowing through blood-vessels. Therefore, if the hot blood in the lungs imparted some of its heat to the air, the latter in passing out helped to withdraw some heat from the body. In taking active exercise we breathe very rapidly, and therefore heated air passes out at more frequent intervals: we eagerly strive to take in the cool air and get rid of the hot air quickly. The increased heat of the body, due to exercise, is therefore checked by rapid breathing and an active flow of water from the skin.

How can a bird get rid of this superfluous heat ? Not by the passage of hot waste fluid through the skin : for we have seen that there is no machinery by which this arrangement can be carried out. In other words, evaporation of fluid from the skin cannot take place. The large, very active kidneys must surely come to the rescue. Mark you : the outgoing air from the lungs and air-sacks is hot, and of course carries away an appreciable amount of the extra heat produced by exercise.

AIR-SACKS AND BODY-TEMPERATURE.

Think of the *extensive size* of some of the air-sacks, and of the remarkable manner in which large numbers, great and small, are scattered all through the body : furthermore, think of the peculiarly high body-temperature, (for a bird is a much hotter creature than a man), and it at once becomes manifest that when the surfaces of the air-sacks, forming in all an immense area, are exposed to copious in-draughts of fresh cold air, they must immediately rob the body of heat ; and when, through violent exercise, this heat is excessive they help to bring it down to the normal temperature. Obviously, then, the air-sacks constitute quite an efficient mechanism for the business of helping to regulate the body-temperature. Though no moisture passes through a bird's skin (in other words, although it never sweats)—nevertheless it flies very fast and frequently for a lengthened time under the fierce rays of a tropical sun with no discomfort. Birds breathe rapidly, more especially when flying against a resisting high head-wind, in which circumstances they cannot glide or plane, but are obliged to flap their wings very energetically. However, the rapid in-rushes of cold air into the spacious air-chambers, at once supplant the air *already heated by the blood* : in that way the air-

chambers, like hot-houses, can become cooled down, and consequently the body generally. Such, then, are the functions of the organs which impinge against the back-bone,—in other words, which lie snugly on the bottom of the 'box.' (Fig. 34.)

THE BOX OF TOYS INVERTED.

Let us once again refer to our illustration of *the box of toys*, which I mentioned in the last chapter. Some of the toys were exceedingly light in weight ; these were gummed to the bottom of the box. When the latter was turned upside down they did not move from their place : only the heavy ones, which lay free in the box, fell out when the lid was removed. We learned that the light toys could not interfere with the balance of the inverted box when the heavy toys rested on the inner surface of its lid. But even when the heavy toys were removed, the box still maintained its position upside down, clearly showing how extremely light in weight the gummed toys must have been. Now, supposing that we had opened our bird's body when holding it upside down, that is to say, with the breast-bone looking to the ground, we should have noticed the heavy organs (stomach, heart, intestine, liver, and pancreas) *protruding*, and, were it not for their connections at either end, they would have fallen out completely. Remember, however, that we had merely to snip with the scissors the gullet at the head-end and the lower part of the intestine at the tail-end, together with the connecting membrane, in order to liberate these heavy organs. Note ! the light organs, before we removed them or cut their membranous coverings, behaved just like the light toys. 'They kept their position in the bottom of the upside-down 'box,' although the lid was removed. What prevented these organs from falling out ? Surely they were 'strapped' to the bottom of

the 'box' by membranes. (Fig. 34.) Remember all three—lungs, air-sacks and kidneys,—are light enough in weight not to interfere in any way with the balance of the flying bird, who in position, then represents the 'box' upside down! Here we should of course note, that except in the case of birds which carry themselves markedly erect on land—for instance, penguins, guillemots, puffins, and some other diving species,—the breast-bone looks for the most part towards the ground, whether the bird be walking or flying. Moreover, those which maintain their bodies erect on land (so that their breast-bone looks forwards), immediately change their deportment when they enter the water, the breast-bone now looking downwards. Therefore, we must remember that when we compare the bird's body to a box and its breast-bone and coverings to its lid, *it is a box which is carried upside-down!*

THE 'BOX' RIGHT WAY UP.

It is only when we place the dead bird upon its back on the table with the breast looking uppermost, that the body represents a *box standing right way up*.

Lastly, before finishing our study of the contents of the body-cavity, observe two large air-tubes, each entering its respective lung. These form a pair and are collectively called the *bronchi*: each is known as a *bronchus*. Follow them upwards and observe that they unite to form a single tube which is called the *trachea*. A smaller and lower portion of this tube is contained *within* the body-cavity, but the major part in passing out, ascends into the neck. In the next chapter we shall have several interesting things to learn about this splendid long pipe.

CHAPTER XIII.

THE MAIN AIR-SHAFT.

A CHIMNEY REMARKABLE IN LENGTH AND ARCHITECTURE.

Trachea, or 'wind-pipe' remarkably long in birds—Greater part situated in the neck—Lower part enters body-cavity and divides—Branches—Bronchi—Upper end opens on floor of mouth—Amazing length of trachea in some birds—Coils of the tube accommodated in hollow chamber in keel of breast-bone—Trachea of Whooper-Crane measures length of the bird itself—Composition—Series of bony rings, sometimes cartilaginous, linked to one another by highly elastic membrane—Rings bevelled and overlap when tube is shortened—When fully stretched the tube doubles its length in many birds—Trachea flexuous—Follows the free movements of the neck—Bore of tube generally uniform—Dilated in some birds—The tracheal 'box' in ducks—Resounding chamber—Voice-organ in Man placed above trachea—Larynx in Bird much simpler, with no vocal cords—Conical 'mouthpiece' at upper end of tracheal pipe—Simple slit-shaped opening on floor of mouth—General description of the avian 'Song-Box'—The Canary's carol and trills.

HAVING now studied most of the organs which occupied the body-cavity, we should proceed to examine the two large air-tubes, each of which is connected with its respective lung, and constitutes a *bronchus*. When followed upwards they unite into a single remarkable tube, called the *trachea*. Only the lower portion of the latter is contained in the body-cavity; most of it is prolonged upwards into the neck, and it terminates in an opening situated on the floor of the mouth. The trachea is commonly

known as the 'wind-pipe,' but remember the bronchi are also wind-pipes. The common disease called *bronchitis* signifies an inflammatory state of these tubes. The avian trachea is a specifically long pipe, very much longer proportionately than the human trachea. All birds have a long neck; that is why their trachea is so long. In life, the neck is frequently carried



FIG 38.—STERNUM OF WHOOPING-CRANE.

"It is amusing to think of a Whooping-Crane.....possessing a trachea as long as itself."

The outer wall of the hollow keel has been cut away to display the coils of the immensely long trachea. (After Cones).

in a contracted position, but the arched outline is masked by the thick covering of feathers. Hence when a bird sinks its head between its shoulders its neck may appear quite short. It is noteworthy that the trachea in some species (for instance, cranes and swans), is much longer than the neck, and is accommodated partly in the keel of the breast-bone, in which

it lies coiled. It is amusing to think of a whooping-crane (an American bird), possessing a trachea as long as itself, with half of the tube (over two feet in length), coiled up snugly in the keel of the breast-bone! In following the course of the trachea up the neck, it should be observed that it terminates on the floor of the mouth. Carefully open the beak of your pigeon, and pull the hard horny tongue forwards, You will then see, behind the tongue, a slit: this is the upper aperture of the trachea. Through this opening the fresh air, for the most part, is first admitted into the body; also the impure air from the lungs and air-sacks escapes mainly through it into the surrounding atmosphere. When the mouth gapes (as in singing) very little of the air-current escapes through the nostrils. The lower end of the trachea becomes continuous with the two bronchi. (PL. XV. B. Fig. 39, C.)

REMARKABLE ELASTICITY OF TRACHEA.

Having already set free the lungs from their 'beds,' we may at this stage, take hold of them with one hand, and with the other hand exert steady traction on the upper end of the trachea. Are we not at once greatly struck by its marked elasticity! It is still more elastic than the bronchi. Wonderful to relate, when fully stretched it nearly doubles its length. Our next business is to investigate the architecture of this air-shaft. We see a large series of rings. In some birds and other creatures these are composed of pliable yet firm material called *cartilage*, which withstands the varying pressures of adjacent structures without inconvenience. In the avian trachea the rings are more usually composed of bone. They are generally uniform, (resembling one another), and complete, differing from those in Man, which are strictly speaking not rings but horse-shoe shaped structures, closed in behind by



A



B

FIG. 39.

THE FORM AND ARCHITECTURE OF
THE TRACHEA.

A.—Portion of the Avian Trachea,
fully contracted.

B.—Same as A, but fully stretched.

In A, the rings overlap so intimately
that their narrow 'tongues' are
almost hidden by their wide, bevelled
edges. The rings therefore appear
like alternating half-hoops.

In B, the rings are fully separated.
The contour of the complete rings
with their alternating 'tongues' and
bevelled surfaces is clearly seen.

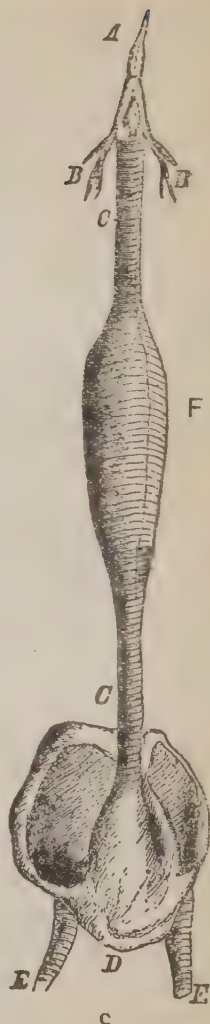
(After Macgillivray).

C.—Trachea of Merganser, viewed
from behind.

A.—Tip of Tongue. B.—Root of
Tongue. C.C.—Trachea, distended
in its middle portion at F. D.—En-
larged 'box' or resounding chamber.
E.E.—Right and Left Bronchus.

Observe :—Between A. and B, the
upper orifice of the Trachea is seen,
immediately behind the tongue.

(After Newton).



membrane. Each ring (whether in bird or mammal), is connected to its neighbour by elastic membrane.

BEVELLED RINGS AND RESOUNDING CHAMBER.

When a bird shortens its trachea, not only has it the power of bringing the adjacent rings into contact, but it can actually cause them to overlap, owing to the curious way in which they are bevelled. (Fig. 39, A.B. Fig. 41. PL. XIV. A.B.)

The entire tracheal tube lies very loosely in the neck. Remember that the latter is highly flexible; consequently the trachea follows all its twists and turns; and, as a result, bends very readily. Though usually straight and of uniform bore, nevertheless, in some birds it is dilated and in others constricted in parts of its extent. (Fig. 39, C.f.) Again, notably in marine ducks, several of the lower rings are joined together and very much enlarged, forming a *spacious 'box' of bone and membrane*. Although this is not part of the true organ of voice (the latter being at a lower level), nevertheless, it probably acts as a *resounding chamber*. When present, it is usually developed, in the male bird. (Fig. 39, C.d.)

THE HUMAN LARYNX.

You have no doubt heard of the *larynx*; perhaps the name is more familiar when we associate it with the affection of the throat called *laryngitis*. In Man the larynx begins as an open tube at the back of the mouth at a slightly lower level than the tongue. It joins the trachea about the middle of the neck. It lies all the time well to the front and can be felt beneath the skin, especially a prominent cartilage of it called 'Adam's Apple.' (Fig. 40, C.t.) The contour of this cartilage can clearly be seen, especially in men, in which it is relatively larger than in women and children. Attached

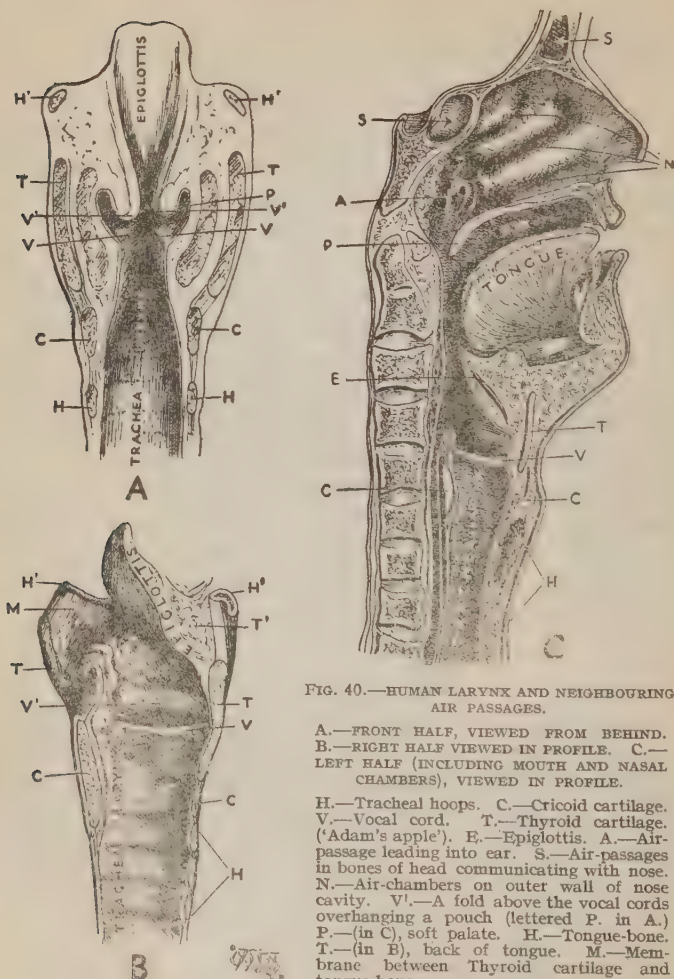


FIG. 40.—HUMAN LARYNX AND NEIGHBOURING AIR PASSAGES.

A.—FRONT HALF, VIEWED FROM BEHIND. B.—RIGHT HALF VIEWED IN PROFILE. C.—LEFT HALF (INCLUDING MOUTH AND NASAL CHAMBERS), VIEWED IN PROFILE.

H.—Tracheal hoops. C.—Cricoid cartilage. V.—Vocal cord. T.—Thyroid cartilage. ('Adam's apple'). E.—Epiglottis. A.—Air-passage leading into ear. S.—Air-passages in bones of head communicating with nose. N.—Air-chambers on outer wall of nose cavity. V'.—A fold above the vocal cords overhanging a pouch (lettered P. in A.) P.—(in C), soft palate. H.—Tongue-bone. T.—(in B), back of tongue. M.—Membrane between Thyroid cartilage and tongue-bone.

"The power of improving tone and resonance, which a good singer must possess, can only be brought about by the air-current being driven through some passages above the larynx. Here the extensive nose-chambers (which open posteriorly on the roof of the mouth), come to the aid of the human vocalist."

to the deep surface of this cartilage, on either side, are the vocal cords. These are prominent, sharp, elastic folds, running almost horizontally in a direction from back to front. When set vibrating, they can give rise to various vocal sounds. (Fig. 40, A.B.C.v.) The cartilages of our larynx are not uniform horse-shoe shaped structures like those of the trachea, with a membrane completing them behind. They are very unlike each other, except the smaller series which are in pairs. One cartilage which is called the *cricoid*, makes a complete ring, similar to the tracheal ring of a bird. (Fig. 40, A.B.C.c.) The adjacent cartilages are firmly connected by elastic membrane, in a similar manner to the way in which the tracheal rings are connected, but the latter are not invested with muscles, whereas the laryngeal muscles are very numerous, and obtain various and extensive attachments; such special machinery is necessary for the purpose of working the vocal cords.

It is evident that our larynx, with its big cartilages and roomy cavity, is, what we may conveniently call our true '*song-box*' and remember again, that it forms the highest part of the wind-pipe, opening above into the back of the mouth behind and a little below the tongue, and becoming directly continuous downwards with the trachea. We therefore speak, sing, and produce other vocal utterances, *by a machine which is placed above our trachea, and situated quite close to our mouth.* (Fig. 40, C. Fig. 43, A.c.)

THE ' LARYNX ' OF BIRDS.

In birds this part of the wind-pipe is much simpler, and although it contains some cartilages and muscles found in the larynx of Man, it possesses *no* true vocal cords, and is not dilated into a resounding box. By its action it can regulate the voice which, we shall see presently, is produced in

the *lower* end of the trachea and upper part of the bronchi. Here the true '*song-box*' of the bird is situated. The so-called '*larynx*' of the bird has aptly been described as a small, simple, conical *mouthpiece*, of the tracheal pipe and its forked bronchi. Here, there is no conspicuous '*Adam's Apple*,' so familiar in the human throat. This much reduced and simplified avian '*larynx*' becomes continuous below with the trachea: above it opens in a very conspicuous chink, running lengthwise from back to front, and situated on the floor of the mouth behind the curious horny tongue. This opening is expanded or made narrow by its sides diverging or converging. We have already examined it in the dead pigeon. It is the same in our Herring-Gull, which I am now inspecting. (PL. XV. A.B. Fig. 39, C.)

EPIGLOTTIS.

The top of our larynx is surmounted by a large leaf-shaped structure called the *epiglottis*, which guards the entrance and prevents food passing into the cavity during swallowing. It is quite rudimentary in the bird, being formed by a very shallow folding of the lining membrane of the floor of the mouth which lies at the front of the air-opening. (Fig. 40, A.B.C.e.)

FORM AND POSITION OF THE AVIAN '*SONG-BOX*.'

Let us make a very quick and quite general inspection of the true '*song-box*.' We shall study it in considerable detail in the following chapter. In the first place look carefully at the lower region of our pigeon's trachea. Here we observe an enlarged cartilage (or bone as is often the case), composed of several completely fused rings. It is called the *tympanum*. A bar of bone running from back to front strengthens the lower end of this cartilage. This bar is known as the *pessulus* or '*bolt-bar*,' and is situated just where

the trachea forks to form the two bronchi. A strong but thin membrane, which is attached to the '*bolt-bar*,' ascends into the trachea vertically, ending in a free concave or crescent-shaped edge. We may name it the *semi-lunar membrane*. In the next chapter we shall see, on opening the '*song-box*,' that this membrane is the common partition between the commencement of each bronchus. (Fig. 41, B. PL. XIV. G.)

Splendid trills can be produced by the best singing birds! Bird-fanciers win prizes for the astounding trills and rolls (as they are called) which their canaries can produce.. What is the machinery which keeps these trilling carols a-going? It is the semi-lunar membrane which is set vibrating when columns of air impinge upon its surface! The semi-lunar membrane is a single structure situated in the middle line, differing in that respect from the human vocal cords, which form a pair, arranged *horizontally* on either side of the middle line. Thus in birds we have one large vocal cord which takes a *vertical* direction as it ascends from the bony bar (the *pessulus*) which limits the trachea below.

This, however is only part of the avian vocal apparatus, the rest of the machinery is likewise full of interest.

Put your specimens back in pickle; we must examine the bronchi very carefully again. Their architecture is astonishingly interesting: the cavity which they enclose provides a veritable Aladdin's cave! It shall be necessary to cut away portions of the walls of the lower end of the trachea and upper ends of the bronchi, in order to 'explore' this wonderful cave! This we shall do, as we proceed with our investigations in the next chapter.

LECTURE 8.

CHAPTER XIV.

THE STRUCTURE AND MECHANISM OF THE SYRINX.

A VERITABLE ALADDIN'S CAVE EXPLORED.

The Syrinx or 'song-box'—Its deep and low position within the body-cavity—Human 'song-box' high up in the neck—Marvellous vocal machine—Prodigious volume of sound through tiny tubes—Great carrying power of voice—Syrinx in most birds too small to study with naked eye—Use of pocket-lens—We make an immense model which opens on hinges to allow a view of interior—Begin by an examination of exterior—Lowest cartilage of trachea, large, deep, and supported by 'bolt-bar'—Pessulus—Wonderful architecture of bronchial loops—Variation in shape, size, and relative distances—Inner attachments—Tympaniform Membrane—Extensive sheet—Very free movements of bronchial loops—Varying tension of tympaniform membrane—Membrane attached above to pessulus—Action of syringeal muscles—Movements of framework tested by pulling muscles on model—View of interior of syrinx—Semi-lunar Membrane—A single vocal cord—Vertical—The mechanism of joyous trills—Two horizontal vocal chords.

TELL me, my young friends, to begin with, what is the scientific name of the bird's '*song-box*'? The *syrinx*, yes; the wonderful machine, which can produce, for its size, amazingly loud and far-reaching musical notes. The syrinx is an organ peculiar to the bird; it is not found in other animals. All our familiar garden-birds have a splendidly

developed 'song-box.' In those species which are endowed with fine singing-powers, special extra muscles are present to work this special vocal machinery. Now what exactly are the parts of your pigeons' bodies which you have just removed from the pickling vessels and placed upon the table? The trachea, bronchi, and lungs, all intact. (PL. XV. A.B. Fig. 43, B.) The trachea, (commonly known as the 'wind-pipe'), again observe, is a very long tube composed of bony rings held together by alternating, intervening, membranes. Below, it separates into two branches, right and left; each of which is called a bronchus. In your pigeons, and indeed in most birds, these air-passages are so small that their fine architecture cannot be made out clearly with the naked eye. To examine the rings and their intervening membranes in detail, it is advisable to procure a pocket-lens. This little instrument becomes still more necessary when we wish to examine the structures which occupy the interior of the tubes and upon which the production of voice, in a large measure, depends.

"Let's pretend" that you each have bought a pocket-lens which will magnify sufficiently to enable you to see quite clearly the various parts of the machinery in the bird's 'song-box.'

IMMENSE VOLUME OF SOUND THROUGH SMALL TUBES.

Cut the wind-pipe across (and remember we had better call this part of the tube by its recognised name, viz., the trachea), and observe that the diameter of its cavity is quite small. The trachea of the Herring-Gull will barely admit a piece of slate-pencil or a wooden knitting-needle. A wax-match would easily distend a robin's trachea. The bronchi are also very small: yet what a volume of sound pours forth through these tiny tubes? A lark can be heard at a distance

when the human voice would be quite inaudible. A wooden-match could choke the trachea of this marvellous songster. Contrast the human trachea, which admits the forefinger of a grown person ! (Fig. 43, d.)

Keep the air-tubes of the actual bird by your side for purposes which will prove useful, while I describe the structure of the syrinx on a huge model which I designed—a model so greatly enlarged that you can put your hand down the tracheal tube.

THE GRAND MODEL.

I have made this grand model in order to facilitate your anatomical studies. Let us call it into practise. Those minute and delicate structures which I have already pointed out upon the air-passages of the pigeon (at which you were afforded only a hurried glance), are now as clear as daylight. Observe ! I have divided a few free tracheal rings, also the fused rings called the tympanic wall and their connecting membranes, and made them to open on hinges, on the principle by which the two segments of the shell of a cockle, mussel, or other bivalved shell-fish, opens. (Fig. 41, B.)

We may now proceed to open the model. In the first place we are much interested to learn that the *organ of voice* is situated remarkably low down in the body, indeed well *inside the body-cavity*. We recollect that the 'song-box' in Man is situated high up in the neck. We see that the lower segment of the trachea and the upper segments of the bronchi form the walls of the avian machine. Within these walls certain vocal membranes are arranged, while other sheet-like membranes complete the inner walls of the bronchi. A bird's 'song-box' or syrinx, as already indicated, is situated at the spot where the trachea forks into the two

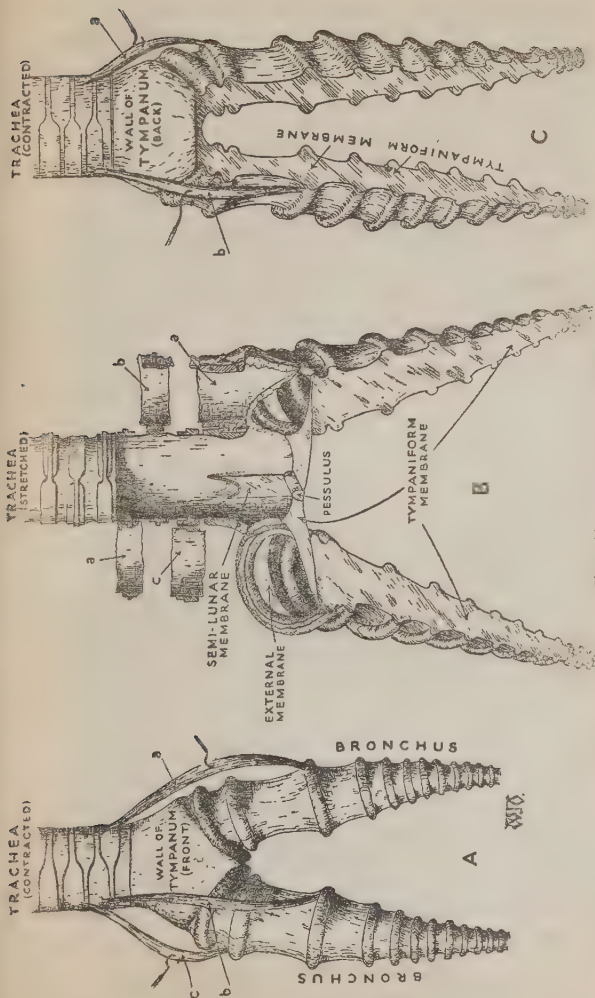


FIG. 41.—THE GRAND MODEL.

"A model so greatly enlarged that you can put your hand down the tracheal tube."

A.—Front view. B.—Front view also. C.—Back view. In B the lowest three tracheal rings together with the tympanic wall have been divided, and the front segments are represented as doors, mounted on hinges and thrown widely open to allow a view of the interior of the tympanic or syringeal cavity. The bronchi are thrust apart and rotated forwards to such an extent that the tympaniform membrane, fully stretched, comes into view, which normally is only visible from the back aspect (Fig. C.) The form and position of the various structures, (all fully labelled above, and described in the text), can be recognised at a glance. It should be observed that the upper four bronchial half-hoops are connected by membranes of varying lengths. In Figs. A and C a few muscles (a.b.c.) are depicted attached to the second and third half-hoops. Their specific actions following their axes of traction, depend upon their exact points of attachments from the lower ends of the tracheal rings to the bronchial half-hoops.

bronchial tubes. Since the trachea is a very long tube, there was no occasion to make a model of its entire length. I have only represented a few of the lower rings.

Let us close the model for a few minutes while we inspect in detail the lowest part of the tracheal wall.

TYMPANUM AND PESSULUS.

We note that it is composed of a very large, strong, and deep cartilage (or bone as the case may be), which is made up of several ordinary-sized rings cemented together. This big cartilage forms a complete ring, though the outline of its cavity is not circular. It encloses the *tympanum*. (Fig. 4I, A.C.)

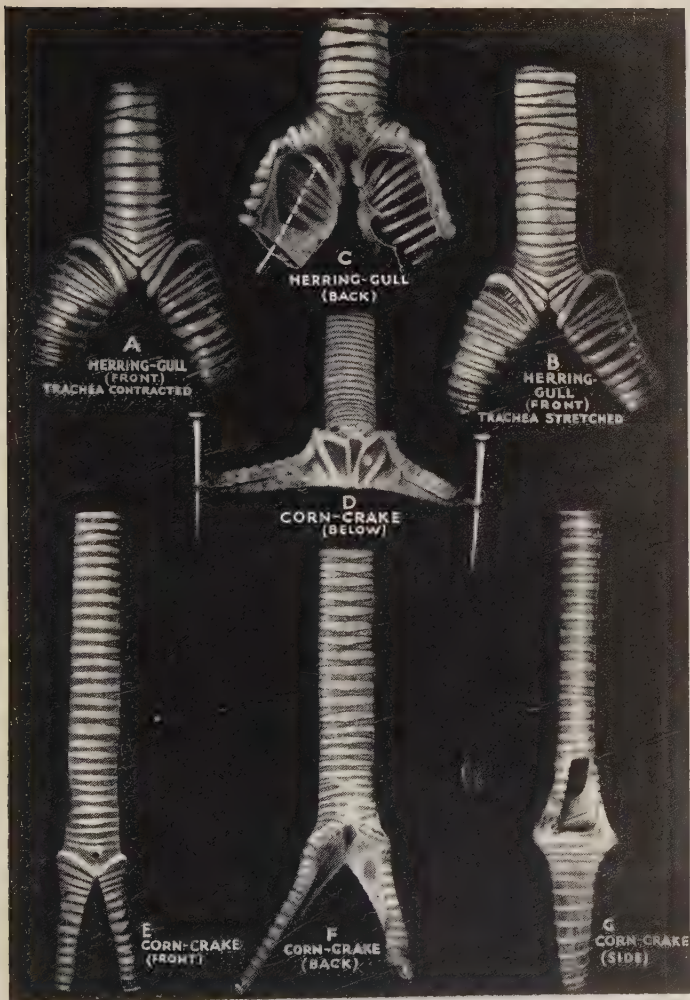
We open the model again and obtain a splendid view of the very strong bar of bone which runs across the lowest part of the trachea from back to front. Remember I have already mentioned the name of this bar ; it is called the pessulus or 'bolt-bar.' We also see clearly the membrane which rises vertically from this bar and terminates in a free edge, neatly curved like the crescent of a young moon. I thought it useful to manufacture this structure from a piece of stretched parchment, and then add to its upper free edge a piece of fine wire. Now flick the wire with your finger and note that the vibrations which are set up emit a nice musical sound. (Fig. 4I, B.)

SEMI-LUNAR MEMBRANE.

This vertical vocal cord, with its free edge shaped like a young moon or crescent, is called appropriately the *semi-lunar membrane*. (Fig. 4I, B.)

Observe that it rises up into the trachea, dividing that tube *internally* into two channels for a short distance. These are continued downwards into the respective bronchial tubes at the level of the *pessulus*, in other words where the *entire* trachea

A Unique 'Song-Box.'



(From specimens dissected and photographed by the Author.)

SYRINX OF THE HERRING-GULL AND THE CORN-CRAKE.

In C, an arrow, in the left bronchial cavity, is seen shining through the tympaniform membrane. The corresponding membrane, completing the right bronchial cavity, has been cut away.

In E and F, observe in the tympanic wall a circular opening which leads into an air-chamber. The latter is seen in the middle line in D, immediately to the left of a bubble, imprisoned in the tympanic cavity.

In G, the semi-lunar membrane, surmounting the pessulus, is clearly indicated.

For further details consult Fig. 41.

divides. There is but *one* semi-lunar membrane, occupying strictly the middle line of the trachea, whereas our vocal cords, two in number, are arranged *horizontally* on each side of the middle line. However, one vocal cord would not be sufficient for the requirements of the many different forms of utterances which the majority of birds can produce. The semi-lunar membrane may play an important part in the production of joyous trills. Birds however also can produce steady, sustained notes, and here the bronchial vocal membranes lend their aid. The bronchial tubes in the bird are marvellously designed for the purpose of voice-production. The bronchi in Man are much more simply constructed: they consist of a series of complete rings connected by membranes. Each ring resembles its fellow above and below. These tubes are not acted upon by a system of muscles, and although they can slightly increase their length, and also can slightly constrict their diameter, nevertheless, they play no part in the production of voice.

HALF-HOOPS AND VOCAL BRONCHIAL MEMBRANES.

Observe on the model the wonderful architecture of the avian bronchi. The upper rings are only *half-hoops*: these are completed on their inner sides (that is to say where each bronchus faces its fellow), each by an extensive sheet called the *tympaform membrane*, which can be stretched as tightly as a drum-membrane or relaxed, according as certain muscles act upon the half hoops. Notice, further, a very remarkable feature in the avian bronchi. The half-hoops vary in shape to a considerable extent. Some are broader and thicker than others. Again, the intervening membrane between two adjacent bronchial rings may vary to such a remarkable extent that the distances between different pairs of adjacent rings are

not by any means uniform. The range and direction of the movement of the bronchial half-hoops is also subject to considerable variation. Hoops separated by wide membranous intervals are granted the greatest range of movement. Observe the second and the third hoops ; the membranous interval by which they are separated is fully twice as great as that by which the first and the second hoops are separated. An intermediate condition is clearly seen in regard to the third and the fourth hoops. Below the fourth hoop, the intervals are much lessened, and as we trace the bronchial wall downwards towards the lungs, we notice that the hoops become uniform in character, and, with the gradual disappearance of the membranous inner walls, the half-hoops are replaced by complete rings. In that way the lower portions of the avian bronchi resemble in architecture the simpler condition found in the entire extent of the human bronchi. Each bronchial tympaniform membrane is attached above to the 'bolt-bar' or pessulus. Thus we have now two more membranes attached to this bar of bone, in addition to the semi-lunar membrane. (Fig. 41, B.C. PL. XIV. C.D.F. PL. XV. B.)

HORIZONTAL, VOCAL, MEMBRANES.

We ask ; are there any other vocal membranes ? Open the syrinx and inspect the outer wall of the upper part of either bronchial cavity. Here may be seen a fold of membrane projecting horizontally inwards towards the middle or semi-lunar membrane. This fold varies however in different birds, and is not always present. How many membranes have we found ? Five in all, as follows : a medial vertical one ; the semi-lunar membrane which rises up from the bolt-bar into the lower part of the trachea ; one from each bronchus, which passes in from the outer wall to face the semi-lunar membrane ; and

one very extensive sheet in each bronchus—the tympaniform-membrane—which completes the inner wall, being joined to the extremities of the half-hoops of cartilage and above to the bolt-bar or pessulus. (Fig. 41, B.C.)

ACTION OF VOCAL MUSCLES DEMONSTRATED.

Let us pull some of the muscles which I have modelled on the bronchi. Note how precisely one muscle causes the second half-hoops to rise, another acts on the third half-hoop. When I pull yet another muscle rotation of a half-hoop follows. While the muscles are being put into action, observe the beautiful manner in which the membranes respond. Some muscles stretch certain parts of the bronchi, that is to say increase the intervals between rings, and consequently *tighten* the extensive inner membranes. Other muscles, by approximating the rings, *loosen* these membranes. The large numbers of muscles which act upon the bronchial hoops, now separating them, now bringing them together, now rotating them outwards, now inwards, with many other complex combined movements, are the great feature of the syrinx. (Fig. 41, A.a., b., c.C.a., b.)

The relative position of the 'song-box' in Bird and Man is very noteworthy. Just think how striking is the contrast. The avian 'song-box' is situated *away down at the root of its neck* (a neck relatively much longer than our own), *within the chest cavity*. Further down still, the bronchi penetrate the lung-tissue and branch into several smaller tubes which ultimately communicate with the air-spaces of the lung and the special air-sacks. (Fig. 43, B. PL. XIII, xv.)

In the next chapter we shall go on to consider the mechanism which promotes the passage of air-currents along the tubes; an untiring mechanism which, in truth, furnishes the mainspring of the entire vocal apparatus.

CHAPTER XV.

THE VOCAL BELLOWS.

How is the voice actually produced?—Air-currents alone flowing along the tubes, not sufficient—Silence of the breath-currents—The vocal muscles must be thrown into action—The trachea, a vocal pipe—A very long tube like an oboe—Great elasticity, allows approach and separation of tracheal rings—Sudden alterations in length of tube promote resilience—Gradual distension and contraction permit of steady, prolonged vocal sounds—Human trachea and bronchi cannot produce voiced sounds—No muscles, vibrating membranes, nor cords present—In Man, voice is produced in larynx above trachea—Silent current must pass up trachea into larynx—Vocal cords in Man situated a short distance below floor of mouth—Vocal utterances produced quite close to floor of mouth—Various air-passages above larynx—The art of producing nasal resonance—Singing in birds, intuitive—No art in voice-production—No nasal resonance permitted—How are air-currents driven through the tubes?—Lungs, the bellows of the vocal machine—Lack of elasticity in bird's lungs compensated by the presence and action of wonderful system of air-sacks—Air-sacks represent extension and diffusion of parts of the lungs over an immense area of the body.

AT this stage of our studies we must ask ourselves: How do voice sounds actually originate? Pulling muscles to tighten or relax vocal membranes, whether we perform the experiment on the natural specimen or on the model, will not yield the ghost of a sound! Even if it were possible for the living bird to work its syringeal muscles energetically without breathing at the same time, the song-machine would remain quite mute. What then is the real driving force which can throw the membranes into vibrations? It is the current of air during its passage along the bronchi and trachea.

So far that is correct. Let us, however, go a stage further regarding this interesting matter. Is there ever a time in our lives in which a current of air is not flowing along the air-passages? We all know there is not, unless when we forcibly hold our breath. Even then we only can stop down the flow for a few seconds. Two currents, one conveying fresh air to the lungs and passing down the air-tubes, the other conveying impure air from the lungs and passing up the tubes, form the never-ending ebb-and-flow of the breathing or respiratory tide. Vocal utterances, be it observed, in most animals are produced during an outgoing current of air.

We sing, talk, or produce other vocal utterances when breathing out, and, as far as we can judge, this holds good generally speaking in the case of birds. Why then is voice not produced every time a current of air passes out along the tubes? It must impinge upon the vocal membranes of the syrinx in the bird, or, in our own case, the vocal cords of the larynx.

Here is the reason: the vocal membranes are not always tuned up by the vocal muscles to enable them to vibrate when the column of air plays upon them. It is true that the vocal membranes approach and recede during ordinary quiet breathing. But the muscles which promote these movements are not voice-muscles, and do not in any way prepare the membranes for vibrations. Hence it is that normal breathing is mutely performed.

VIBRATION OF VOCAL MEMBRANES.

Although by fine artistic skill we may have learned to control fully the outgoing breath, in order to allow for the softest singing effects,—oft-times a mere musical whisper,—nevertheless we always must call the vocal muscles into play

to enable the membranes to vibrate ; and, though we may breathe out our song softly, we have behind it, held in reserve,



FIG. 42.—THE NIGHTINGALE'S PASSIONATE OUTBURST OF MELODY.

"Birds as a race, sing vigorously and loudly : there is no doubt therefore that they send a large swiftly-flowing column of air at considerable pressure through their syrinx."

a mighty column of air issuing from the lungs. In an instant we can increase the speed and pressure of this column and sing with force and vigour.

Birds, as a race, sing vigorously and loudly : there is no doubt therefore that they send a large swiftly-flowing column of air at considerable pressure through their syrinx when vocalising ; then, as already described, the wonderful membranes are set vibrating ; at one moment slowly, producing the deeper notes, at another moment with most astonishing speed which allows of those high soprano trills that carry far outside the range of the human voice. Once more, is it not wonderful to determine that the pitch, volume, colour-tone, and other features of the voice, are regulated by the way the muscles prepare the vocal membranes to vibrate at different speeds ?

VOCALISING POWER OF TRACHEA.

Let me point out that after a bird has produced the notes of its song in the syrinx, the mechanical action of the trachea can still aid materially in giving resilience and mellowness to the tone of the voice. The passage of musical notes up a lengthened pipe would in itself tend to enrich the tones and render them more flute-like. Indeed we may compare the tracheal tube with its sound-producing vibrating membranes at its lower end, and its slit-like opening on the floor of the mouth at the other end, to a long reed instrument, say an *oboe*, which we know produces delightfully rich, mellow, flute-like tones. Furthermore, *that marked resilience*, which simulates joyous, tinkling, bell-like tones, as though produced by certain metals striking together, or by gentle tapping a thin delicate wine-glass, is much enhanced in the avian trachea through the elasticity of its membranes and the extraordinary manner in which the bony rings can approach and recede with great rapidity and suddenness. The rings not only make contact but, owing to their bevelled edges, they overlap with facility. When the trachea is completely contracted it is

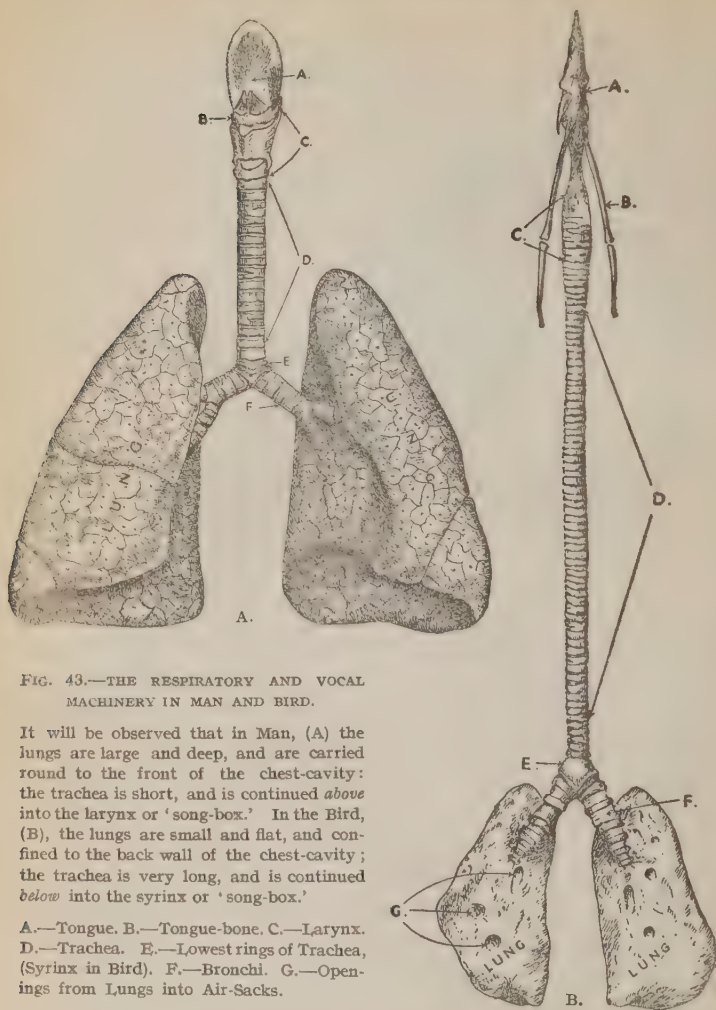


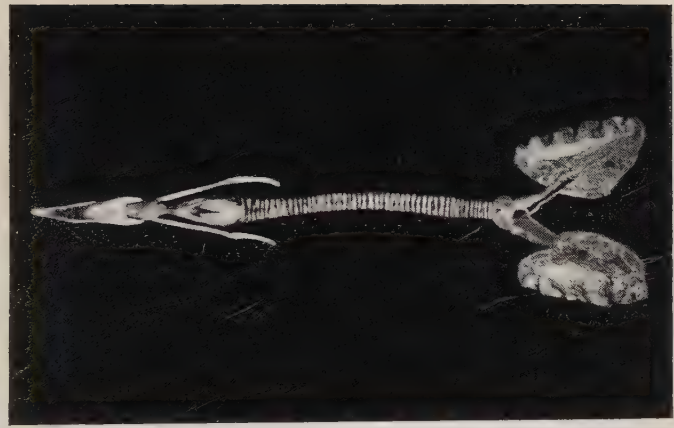
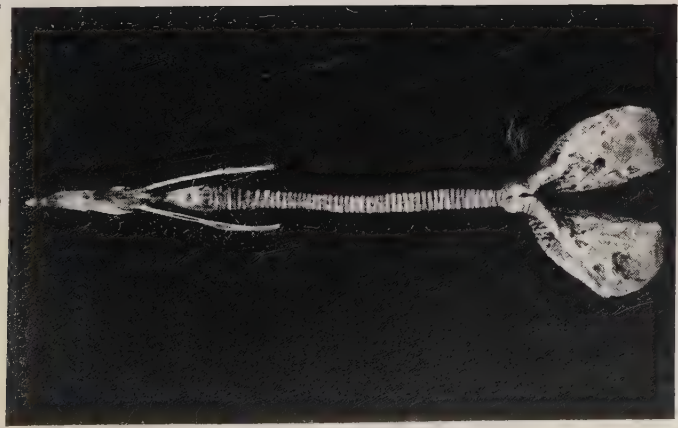
FIG. 43.—THE RESPIRATORY AND VOCAL MACHINERY IN MAN AND BIRD.

It will be observed that in Man, (A) the lungs are large and deep, and are carried round to the front of the chest-cavity: the trachea is short, and is continued *above* into the larynx or 'song-box.' In the Bird, (B), the lungs are small and flat, and confined to the back wall of the chest-cavity; the trachea is very long, and is continued *below* into the syrinx or 'song-box.'

A.—Tongue. B.—Tongue-bone. C.—Larynx. D.—Trachea. E.—Lowest rings of Trachea, (Syrinx in Bird). F.—Bronchi. G.—Openings from Lungs into Air-Sacks.

"The larynx...is the highest portion of our wind-pipe, and opens a little below the floor of our mouth...the vocal cords are situated but a short distance below...human vocal utterances...are produced close to the floor of the mouth." "The avian song box is situated away down at the root of the neck, (a neck relatively much longer than our own), within the chest cavity."

The Complete Vocal Machine.



A.—FRONT.

RESPIRATORY AND VOCAL MACHINERY IN THE ROOK.

B.—BACK.

(Photos by the Author.)

"We may compare the tracheal tube with its....vibrating membranes....and its slit-like opening....to a long reed instrument....which we know produces delightfully rich, mellow, flute-like tones."

For details consult Fig. 39, C. Fig. 43, B.



reduced to half its maximum length! Lastly the tracheal tube is capable of considerable distension, though this feature varies markedly in different kinds of birds. In this way it is easy to understand that as the tube contracts to regain its normal diameter, vocal utterances passing through would gain in duration and steadiness. (Figs. 39, A.B.C.f., 41, A.B.C.)

HUMAN TRACHEA MUTE.

Our trachea is vastly different in this respect: When we sing, even with the greatest amount of vigour, the bronchi and trachea, having no vibrating membranes, remain quite mute. This holds good no matter how swift and compressed may be the current of air which is being propelled along these tubes. This silent current must pass up well beyond the trachea into that higher compartment, called the larynx, before it can set the vocal cords vibrating. The larynx, we have already seen, is the highest portion of our wind-pipe, and opens a little below the floor of our mouth. (Fig. 40, C.) From this region the vocal cords are situated but a short distance below, hence all human vocal utterances in the first instance, are produced close to the floor of the mouth. Now as the human bronchi and trachea play no part in vocalising, it follows therefore that the power of improving tone and resonance, which a good singer must possess, can only be brought about by the air-current being driven through some *passages above the larynx*. Here the extensive nose-chambers (which open posteriorly on the roof of the mouth) come to the aid of the human vocalist. In birds, these chambers are too small and shallow, and the mouth, beak, and tongue, too hard and rigid to bring any influence to bear upon the quality or resonance of the notes, after they have flowed out freely from the tracheal tube. (Fig. 40, C.n.)

AIR-CURRENTS AND THE BELLOWS.

But there remains a very important question to decide before we can complete our study of the voice-machine? We have spoken of swift currents of air travelling through the air tubes. What causes these currents? Is it correct to say that we draw in our breath? No. We expand the chest-cavity and the air rushes in and fills the lungs. Our lungs are composed of innumerable microscopic air-sacks, all closely packed together. They become soaked with air as a sponge becomes soaked with water. But they are very elastic, and directly they have been sufficiently filled, and when the chest-cavity starts to contract upon them and drive out the air, they aid readily in the expulsion through their own recoil. It is now becoming clear as to how currents in the tubes are produced? Ask your friend to work an ordinary bellows: the instant its cavity starts to expand, the air rushes in through an opening: when its cavity contracts the air is forced out through an opening. Put your finger to the nozzle and feel the current of air passing out. Surely then our lungs are a pair of magnificent bellows, and, indeed, coupled with the muscular mechanism of the chest-cavity, form the main-spring of the entire vocal machine. Without this machinery no air-currents could flow along the air-tubes.

The lungs of the bird happen to be inelastic, but this deficiency is made good by the presence and powerful action of the numerous and extensively distributed air-sacks. Remember the air-sacks in the bird must be regarded as part and parcel of the lungs which have spread themselves far and wide throughout the body. (Fig. 35, as. PL. XIII.)

We have at length come to the end of our studies in regard to the marvellous machinery of the bird's body. Leave your specimens upon the table; they are no longer needed.

In the next chapter we shall see ourselves rambling in the country, filling *our own lungs with pure fresh air*. Amidst most charming surroundings we shall try and unravel the meaning of bird-language. We shall have a thoroughly good time. I prophecy for you all a delightful day's ramble.

LECTURE 9.

CHAPTER XVI.

THE LANGUAGE OF BIRDS.

Let the Little Ones also come along and listen to the Birds.

A country ramble—Difficulties in observing small woodland birds—Identification by their language—Three-fold purpose of bird-language—The call-note—Migration—Mating—The young bird's appeal—Features common to all call-notes—Musical, melodious, sympathetic—Long distance carrying powers—Difficulties in describing bird-language—No consonants, labials, nor dentals—Birds have neither lips nor teeth—Song evolved in part from call-notes—Melodious call-notes of birds without song—Notably, shore-birds—Curlew, redshank, greenshank, and others—Call-note may serve as alarm-note, example: musical cry of curlew—The alarm-note—Warning, alarm, battle—Alarm-note often unmusical—Limited carrying power—Uttered when enemy at close quarters—Message relayed from one bird to another—Alarm-note sometimes an expression of right of territory—Mating-season—Usual features of alarm-notes—Monotonous repetition—Little dog kindles the wrath of a chaffinch—A shower of abusive language—We discover the reason—Dog finds the nest—The brooding mate slips off her eggs—Her spouse now calls plaintively—We witness her return—We withdraw—Mr. Chaffinch pours forth his gladsome carol—'All goes well'—Another Mr. Chaffinch sings vigorously—Rival vocalists—Territorial rights—Robins' fierce but tuneful duel—Pugnacity and song—Mrs. Robin enjoys the music and selects the best artist—Missel-Thrush's heated argument with a magpie—We enter the wood and sit down to listen—The ripples of the brooklet grow more and more melodious—We discover the source of the music—The enchanting 'water-bubble' song of the blackcap—We hear the

garden-warbler, another superb singer — An irate whitethroat scolds 'Doggie' in harsh language — Willow-warblers in chorus — Wood-warbler adds to the music of the shimmering leaves — Farewell, glorious songsters — We start for home and hear a cuckoo — A simple two syllabled, monotonous song — Corn-crake utters his rasping notes — A dreadfully unmusical song — Over the buildings of the busy city we hear the simple language of the swifts, a 'highly-pitched squeak' — What are these birds saying? — 'Away, you rivals, enter for the race and test your speed on the wing' — Call-note and song combined in one utterance, very feebly-developed.

JOIN me in a country ramble, my dear young friends : it will do you no end of good after your diligent indoor anatomical studies. What you have now learned will be of the greatest benefit in preparing you to understand and to become thoroughly interested in the language of birds. We have seen that voice-production is developed to a marvellous pitch of perfection ; that the syrinx is not present in any other class of animals ; that this unique organ possesses more vocal membranes than are found in other animals ; and so, without going over anatomical ground already traversed, I feel sure you expect that birds, as a class, ought to be able to pour forth a great variety of different kinds of utterances. In other words they ought to have quite a comprehensive vocabulary from which their language has sprung.

"Let's pretend" that it is a lovely, soft, warm, calm day in the latter half of the month of May. The sun is shining brightly at the present moment, but bring your water-proofs, we shall have a shower or two, albeit gentle, of short duration, and very acceptable for our purposes. Towards the end of these sprinklings and for a little while after (when the moisture evaporating from the foliage imparts to the atmosphere a refreshing sense of balminess and fragrance), we shall find our feathered friends all the more loquacious ; so much the better for us in our endeavours to master their language.

We are about to make an early start, remember, at 8 a.m. sharp, so bring plenty of lunch, which we shall eat five hours later in some secluded spot, away from the noise of traffic. If we are content to picnic in a quiet manner, we may hear some very entertaining bird-language.

IDENTIFICATION OF WOODLAND BIRDS BY VOICE.

It is often extremely difficult to see small birds in a wood, even in a plantation of a few acres. For several reasons: many species inhabiting timbered localities are naturally shy and extremely watchful; their plumage is inconspicuous and closely harmonises with the surrounding foliage, the thickness of which in turn obscures the view; small woodland birds are amazingly active and move with rapidity from tree to tree in search of flies and other winged insects. Therefore, unless we learn to identify the utterances of these different species, we may overlook their presence altogether. When we reach the haunts of woodland birds, we shall pay special attention to their language; this shall be a real pleasure, seeing that these species are gifted with unique powers of expressing themselves in strains of sweetest melody. In the meantime, as we ramble along through green-lanes encompassed by hedgerows surmounting charming little embankments (thickly studded with primroses, mosses, ferns, and other vegetation, all luxuriant, all eagerly pressing forwards in the competition for 'standing-room'), we shall come across many familiar birds, some of which are frequently to be seen in our own suburban gardens. I am most anxious, in the first place, that you should become quite familiar with their voices. Now while we are riding on the car to get clear of the city, let me economise time by telling you some very interesting facts about avian utterances.

PURPORT OF BIRD-LANGUAGE.

Speaking generally, the language of birds serves a three-fold purpose. Firstly, it furnishes means whereby individuals can readily keep in touch with one another when carrying out the duties of everyday life. Bear in mind that birds are mainly creatures of the air and, owing to their swiftness of flight, they might very readily become separated from their companions to a dangerous degree. Birds have immense appetites, and consequently are obliged to wander about almost incessantly in search of food. Members, therefore, of a large foraging party find it to their advantage to keep up conversation! When undertaking lengthy migrations across land and sea, it is most important that the flocks should move along in as compact a mass as possible. Hence the incessant cries of '*follow the leaders*,' given out by the members in the vanguard, are taken up by many others in the rearguard who say (as we translate it) '*yes, we are with you*.' In the spring, when birds are pairing, the male must constantly know the whereabouts of his partner, more especially when they have only been but a short time wedded. This is absolutely necessary for protective purposes, consequently he frequently calls aloud to her as they move on from tree to tree or shrub to shrub, in search of food and a suitable nesting-site. Again, we find that even the helpless, unfledged nestling has a voice powerful enough to send forth messages of distress for food, for warmth, for protection. These utterances are poured forth by the offspring for many weeks after it has flown from the nest. The parents reply in very sympathetic tones, which, in bird-language, are the *call-notes*.

THE CALL-NOTES.

This is our translation, and it is absolutely correct, for it is founded upon direct observation. I feel sure that we

shall be able to put this matter to the test by confirming some of these observations. But first I must tell you that there are well-marked features which are common to all call-notes. They are rarely other than musical, and their tones are so pure that they carry a very long distance ; they are often exquisitely plaintive, and melodious, and seem to express sympathy in a marked degree. To attract attention and render the call-notes all the more expressive we find that they are composed of *two syllables*, and the second is usually a third or a fifth higher in pitch than the first syllable. Those of you who know a little about music will understand what I mean when I say that the intervals in pitch in the call-notes follow fairly well those found in the diatonic scale. It is with intervals in this scale that we are most familiar in melody and in the building up of harmony ; hence the bird's melodious call-notes fall tunefully on our ears.

DIFFICULTIES IN REPRODUCING BIRD-NOTES.

It is often very difficult to express in words or reproduce the utterances of birds. Purely formed and distinct consonants are seldom detectable : this is as we should expect, seeing that birds are without teeth, and movable lips ; moreover (with few exceptions), the tongue is a dry, horny, pointed, rigid structure. Its vibrations, however, may perhaps serve as a reed, and add colour to the enchanting trills which enrich the songs of our best avian vocalists. The call-notes, syllabled *you-ee*, are common to many birds, especially the *warblers*, which are the sweetest songsters of the feathered world ! Although these utterances vary considerably in pitch and tone according to species, they are astonishingly melodious, and lay the foundation of the unique '*water-bubble*' trills and rolls of the finished song. But here let it be clearly understood

❧ Melody o'er the Beach. ❧



(Photo by H. Brooke.)

A.—REDSHANK.

GREENSHANK.

REDSHANK.

"There are birds in which the song....forms no part of their language; nevertheless, they possess plaintive and sweetly melodious call-notes."



(Photo by the Author.)

B.—RINGED PLOVERS, NEST AND EGGS.

"Many shore-birds, such as the curlew, redshank, greenshank, and ringed plover, are thus endowed. Moreover, in these and several others....which frequent the open beach....the call-notes may also serve as alarm-notes."

that there are birds in which the song, in the strict sense of the word, has not become evolved, and therefore forms no part of their language; nevertheless, they possess plaintive and sweetly melodious call-notes. Many shore-birds, such as the curlew, redshank, greenshank, and ringed plover, are thus endowed. Moreover in these and several others of their kind which frequent the open beach and slob-lands, the call-notes may also serve as alarm-notes. The grand and wild musical cry of the curlew no doubt often plays the part of a multiple code. (PL. XVI.)

ALARM-NOTES AND BATTLE-CRIES.

Next we can interpret in the language of birds certain utterances which are unmistakeably poured forth for the purposes of warning, alarm, or even battle. These are known as the *alarm-notes*. When the common enemy appears in sight, even when still afar off, a babel of sounds soon fills the air; the feathered communities far and wide are all intent on thwarting the plundering adversary. The alarm-notes are not necessarily musical, indeed some of them are otherwise, being harsh and full of overtones. They do not, as a rule, carry so far distant as the call-notes; obviously, there is no necessity why they should, because they are most vigorously uttered when the enemy is being engaged at close quarters. Indeed the message of warning depends not upon the direct projection of far-reaching utterances, but rather upon the message being taken up and relayed by one bird to another. This is effected in an extraordinarily prompt manner. The language used when engaging the common enemy in battle, is similar to that adopted when rivals of the same species take up cudgels in regard to the right of territory and other claims concerned with the domestic side of bird-life. (Fig. 44.)

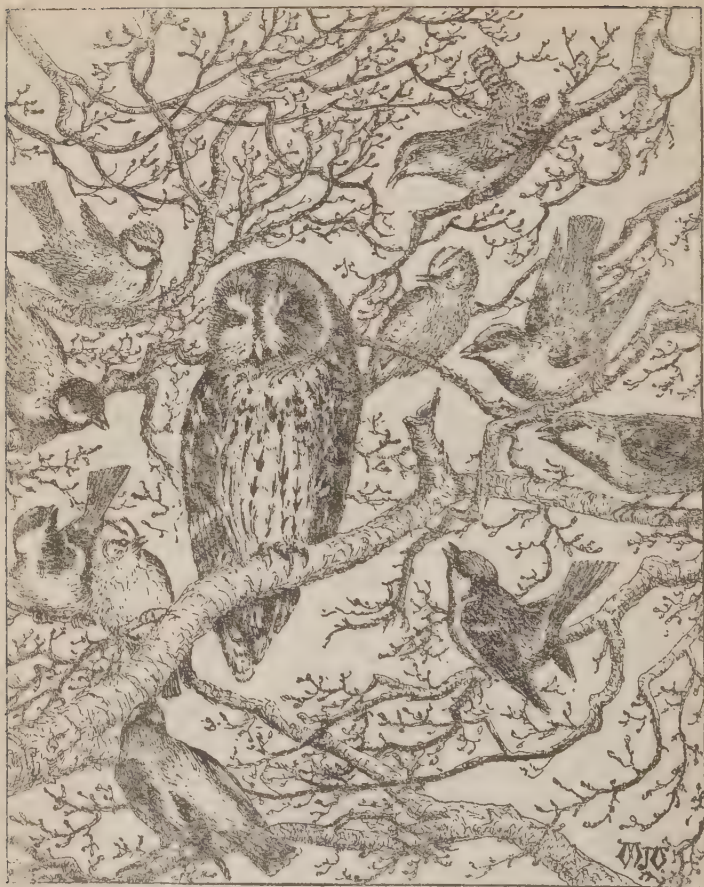


FIG. 44.—THE OWL'S SIESTA.

"The alarm-notes are not necessarily musical, indeed some of them are otherwise, being harsh and full of overtones. They do not, as a rule, carry so far distant as the call-notes; obviously there is no necessity why they should, because they are most vigorously uttered when the enemy is being engaged at close quarters."

After meals, birds-of-prey amicably tolerate, nay even enjoy, the menacing attitudes and loud discordant battle-cries of the little rioters. The illustration depicts a Tawny Owl which alighted on a rather exposed branch of a sycamore tree still in bud, within a stone's throw of the busy streets of Sheffield. Naturally then, the mob was largely dominated by sparrows and titmice.

In the spring the male birds are highly pugnacious and frequently give vent to their angry feelings in the language of furious battle-cries. Notes of warning, alarm-notes, and battle-cries are all much of a piece. The characteristic feature in regard to these utterances is their monotonous repetition. No charming diatonic scale intervals now fall on the ear. Sometimes we hear but a single squeak, which is repeated after measured intervals. This is the mode in which an angry hedge-sparrow expresses himself.

But just let us wait a minute or two and we shall hear the birds themselves speaking to us in their own language, and I shall then be able to explain their utterances more clearly.

We have alighted from our car and now we are about to turn round the corner of the road and then proceed along a delightful green-lane. Listen! Halt! every single one of you! Did I not tell you we should soon hear the birds themselves speaking to us in their own language?

A CANINE INTRUDER AND AN IRATE CHAFFINCH.

Ah! I see the reason for alarm-notes. One of you has brought a wee little dog! You tell me that he is obedient and quiet. Very good; he will be all the more helpful in attracting the notice of birds and inciting them to sound forth the alarm. When we wish not to disturb the peace of mind of our feathered friends I can pop the tiny dog into my capacious coat-pocket! I am sure he will then fall asleep!

Yes; there goes the familiar *spink.....spink*. Look at him; blithe, sprightly creature! just on that branch overhead. See his lovely snowy-barred wings! Need I proceed further with his description? Of course not! He is a chaffinch. Surely every one knows him. (PL. XX.) But he has not shewn much

alarm as yet. He has only cried *spink* twice, and with a considerable interval between the cries. Let the doggie run forward along the bottom of the hedge. Listen ! *Spink.....spink....spink..spink..spink..spink..spinkspinkspink..spinkspinkspinkspinkspinkspinkspink*. See ! twenty yards ahead this chaffinch is showering down a storm of abusive *spinks*, in very rapid succession, on the dog's head ! Something has been scented, I'll wager ; that is why the intruder has come to a standstill. Let us hasten to the scene. Peep in quietly and, sure enough, behold the female chaffinch sitting closely on her nest, the latter built unusually low down in the thorn-bush. Happily however it is well beyond the dog's reach.

Come, my young friends, quick, over the old wooden gate, and down with you into the ditch at the other side of the hedge. You will be nicely ambushed, and by peeping through the tall sedges and fern-fronds, can keep the nest and mother-bird in view and also watch the doings of the male partner.

THE MALE CHAFFINCH NOW CALLS SWEETLY.

Listen ! What do we hear ?

Yes ; the male calling. What different notes he now produces ; so pure and sweet, so soft and yet far-reaching. They are two-syllabled and therefore typical, and they sound like *tu-whit*. Why should he call ? Let one of you advance along with me noiselessly on tiptoes, until we can see the nest more clearly. Now tell me. What do you see ? Let me put the question so that the answer will appeal to you all the more forcibly. What do you *not* see ? The female bird on the nest ? Yes ; the presence of the dog and hundreds of human eyes, all eager to catch a glimpse of the sitting-bird, no doubt scared her away. But she will not be long in responding to her husband's earnest entreaties to return.

You thought you saw a little bird wending its way stealthily through the thorn-hedge close to where the nest is placed ? You have been most attentive and have kept a very sharp look out. I missed the observation, but suspect that the bird you saw was the female chaffinch returning. Let me have a peep at closer range. Yes ; there she sits contentedly. Let us retire and leave her in peace. Get over the old wooden gate and on to the pathway again. We shall stroll along this delightful green-lane, then cross the fields towards the woods.

THE CHAFFINCH NOW SINGS HIS BLITHE, JOYOUS SONG.

Hark ! What a blithe, joyous carol ! Three, four, five, or even six words exactly similar, followed by three different words, poured forth *allegro* in very rapid succession, all forming an elegant and most lively stanza. You hear it repeated with indefatigable zeal. We are all quite familiar with this song. Do you think that Mr. Chaffinch will allow me to translate his verse into our tongue ? I shall risk it in the hope of not giving him displeasure ! “ RING, RING, RING, RING, RATTLE, SISTER DEAR, CHEERIO ! ” Listen ! There he goes again. Am I very wide of the mark in my translation ? Only we must supply the consonants, because poor Mr. ‘ Chaffy ’ has no lips nor teeth ! Now you have actually heard the *song proper*, which is the last and most important of the three-fold purpose which *bird-language* serves.

We ask ; why did the chaffinch sing ? In the first place to let his wife know that all was going well. We strolled away ; she was in his company ; no enemy was in sight ; therefore there was no need for her spouse to call her or sound the battle-cry : so he turned on his tuneful melody. Not only has he been telling her that ‘ *all goes well*, ’ but also that no

other rival male chaffinch has entered within the precincts of his rightful territory.

A RIVAL SINGS.

Hark ! List ye again ! Right ahead another chaffinch has just burst forth into joyous rhapsody. He seems to be singing even more vigorously than our first bird. Of course, he is. Do you not see the reason ? There is rivalry, very keen rivalry, between the two vocalists ! This wonderful feature stimulates bird-song to grow more and more perfect and elaborate. From where we now stand we can plainly hear the rival vocalists chanting antiphonally and in the most passionate strains. Each is fully respecting the other's rights, and consequently is singing defiantly at a *civil* distance apart. Walk on, keeping your eyes wide open all the time. Look along the ditch and amidst the luxuriant vegetation growing on the embankment.

ROBIN'S DUEL SONG—FEMALE WEDS THE BEST VOCALIST.

Who are those two creatures almost half hidden from view behind that clump of bluebells ? Take a step to the right. Now you get a good view of them.

Look quickly, and note that their red breasts stand out in marked contrast to the colour of the flowers !

You ask what are these two robins doing ? Nothing, I am afraid, to their credit ! They are quarrelling ; I thought as much. Look ! They have come to close grips and some feathers are flying ! Happily they have again let go ; but, *dear me*, look ; they are once more approaching. Now, *within a beak's length*, they have stopped short and, marvellous to relate, *are singing at each other in most defiant attitudes !* What then have we just learned ? That bird-song is often associated with extreme pugnacity !

~ Melody in Battle. ~



THE ROBINS' TUNEFUL DUEL.

"You ask what are these two robins doing? Nothing, I am afraid, to their credit! They are quarrelling....and, marvellous to relate, are singing at each other in most defiant attitudes!"

The bird on the left is singing, although his beak is closed! Observe, the ruffled feathers of his distended throat: he is in a desperate rage!

Robins are notoriously pugnacious, but very many other kinds of birds also sing during a quarrel. The cause of dispute is usually in respect to a female, which both rivals cannot wed ; when the tempers of the two male robins have cooled down, and the birds have sought out their rightful territories, and there have embarked on a singing contest, their dispute will, a little later on, be settled by the female, who will decide to marry the suitor gifted with the superior vocal qualities.

We have thus learned another point in regard to song, and a very important one : namely, that singing interests the female and imbues her with varying degrees of pleasure ; she is careful in her choice, and mates with the singer who charms her most.

A BEE-LINE FOR THE WOODS.

Come, my young friends ; up and over the stile and away with you across the fields, as fast as your nimble legs can travel. Make a *bee-line* all the time for the dense woods yonder ! Halt a minute ! Observe quickly that fine large bird which has just flown from the tall ash-tree in the middle of the field. See ; he has engaged in an aerial battle with a magpie, at whom he lets go a storm of abusive language ! His rapidly oft-repeated, chattering battle-cry reminds us of the noise of one of those loud rattles used to scare birds from corn-fields or fruit-plantations. The magpie is a notorious egg-robber ; well the missel-thrush knows it, and with undaunted courage now drives the pirate away. At the approach of a hawk, the missel-thrush would likewise immediately launch an attack in quite as courageous a manner.

Isn't the shade of the trees refreshing after several hours' exposure to the fierce rays of the sun? Let us walk a few yards further into the wood, where I know there is a brooklet. We can then fill our kettles from its crystal, flowing waters.

Sit down, young friends; fall to and feed. Doubtless, you must be hungry.

THE ENCHANTED BROOKLET.

Listen to the babbling of the brooklet; it has a mellow sound. Tell me, have you noticed that the bubbles of water oft emit sweet and flute-like music? There, listen! They seem to have *ventriloquial powers*; to my ear the '*water-bubble*' music has shifted to the left side of the brook, and now flows from the depths of the *wild-rose thicket* yonder. Listen again and again to the sweet music! Has it not become the enchantress of the glade? Now the '*bubbles*' begin to carol; now we feel as though the chords of the inmost soul of the wild-rose have been set vibrating. But the sweet, vibrating strings are as yet disjointed; the carols are intermittent and stop all too abruptly.

THE BLACKCAP, A PRINCE OF SONG.

Why? Because the *blackcap*, a prince of feathered songsters, is on the move in search of food, treading his way through the densest part of the entangled undergrowth. When thus engaged he usually emits only very few rich notes, *priceless, however, in quality*. Such incantations however give but a faint idea of the power, and vocal beauty in all its fulness, sweetness, and depth, which this soulful songster can create when he stops and warbles his verses in full. He is dreadfully shy, and the odds are greatly against him appearing before such a vast audience! There! He has, of a sudden, come to a

standstill for a moment. We have just heard his amazingly *rich, mellow, rolling, bubbling*, verses, indescribably *sweet* in tone. Away from behind there comes wafted to our ears another charming, mellow carolling, but hardly so rich and soulful in tone as that of the blackcap, yet with very much the same setting. Its author is the garden-warbler.

Now you hear the greater whitethroat, an extremely abundant summer-migrant ; he also has the *warble-setting*, but the tones are inferior in quality, sometimes a trifle strident, though on the whole his song is lively and pleasing.

BATTLE-CRIES.

Take out the doggie from my pocket !

Wake up, little animal !

Here is a unique opportunity to make the whitethroat angry because the bird is close by its nesting-site.

See, it has moss in its beak !

What harsh, jarring, scolding, words he bestows upon the poor innocent canine head !

Come, puppy, disturb him no more.

Jump into my pocket this instant !

CHORAL FUGUE OF WILLOW-WARBLEDERS.

The wood resounds with the chorus of willow-warblers. Listen ! Through sheer weight of numbers, their incessant incantations constitute the very basis of concerted music. Look ahead and you perceive *six* of these delightful birds in that wide-spreading elm. Hear them chanting in *fugal form* their plaintive, yet silvery-toned *fugal melody*.

Pack up your utensils quickly and move deeper into the wood : I am anxious that you should hear a willow-warbler singing alone. Already I hear him in the distance. Hurry on

and make for the low shrub growing in that marshy patch a hundred yards ahead. Stay, you are close enough; now no other willow-warblers are chiming in. Hence we appreciate all the more, in the song of the soloist, the shades of expression and regular rhythm, now waxing, now waning, now melting away into a plaintive *pianissimo* warbling murmur, imparting a most artistic and affecting finish to a melody rich in sweet and silver tones.

THE ENCHANTED BREEZE.

What a nice, cool, refreshing, gentle breeze has arisen: See! it plays with the beech-leaves and makes them flutter. When this movement is only just perceptible we say that it makes them shimmer. What a tuneful sound the shimmering leaves evoke! At first they seem to sing a little ditty syllabled *tweet, tweet, tweet*, which passes into *teet, teet, teet, tee, tee, tee, zsee, zsee, ee, ee, ee, ee, ee, ee, ee, ee, ee*, the speed of the syllables increasing so fast towards the close that it produces the shimmering effect.

List! the breeze has quite died away. Yet we hear the song of the shimmering leaves. Do you hear its tuneful beginning? Surely no gentle breeze, even if it did rise again, could awaken the foliage into such melody.

THE SHIMMERING CAROL OF THE WOOD-WARBLER.

But a tranquil calm now lulls the foliage to slumber and the song continues to flow from yet another sylvan songster, *the wood-warbler*.

This bird has the wonderful faculty of reeling off the end part of its verses so rapidly, that its quivering, highly-pitched, delicate, tinkling notes *mimic closely* the shimmering of leaves produced by the gentle breeze.

There are several other charming songsters of the woods, but we must be content with to-day's lovely concert: the



FIG. 45.—THE BLACKCAPS' DUEL.

"The soulful song of the blackcap.....may be poured forth in kindled wrath."

shadows of evening are fast creeping; we have been four hours among the trees! How quickly time seems to pass in enjoyment! Time delightfully spent in gaining knowledge.

We shall now direct our steps homewards. By turning to the right and scrambling over that low embankment, we can strike the main road at once : ten minutes' walk will then take us to the tram-terminus.

RICH MELODY KINDLES WRATH.

Just now a word or two more about bird-language whilst we are still walking along the road. Remember that all the enchanting music, which we have been privileged to hear in the woods to-day, carries with it the same purport as the joyous but more common-place carol of the chaffinch. The soulful song of the blackcap or of the garden-warbler may be poured forth in kindled wrath, and the silvery chanting chorus of willow-warblers may signify a keen sense of rivalry. (Fig. 45.)

But whatever be the motive of the song ; in whatever way we may attempt to translate its language, it cannot be gainsaid that we, human listeners, have been granted a tremendous musical treat.

THE LANGUAGE OF THE CUCKOO, CORN-CRAKE, AND SWIFT.

Hullo ! Attention ! The cuckoo is announcing his presence ! We hear his very simple two-syllabled song which he so often repeats that it may tend to grow monotonous. The musical interval between his two notes is a *minor third*.

Again, hulloa ! The corn-crake is singing in the meadow adjoining the road. You never thought that a corn-crake sang ? Yes, indeed he does, and at times we may hear his rival replying. It is a very rough rasping performance. I should deem it pronouncedly grating in tone and much more harsh than the loud rattling *battle-cry* of the intrepid missel-thrush !

True, the song of a bird, curiously enough, may sound unmusical and may grate on one's ears. We were very lucky to hear the cuckoo and corn-crake just before boarding our tramcar. Look up ! There are some swifts flying overhead ; they remain in the sky till late in the evening, in fact until almost nightfall. They are birds of the town rather than of the country-side, and may be seen hawking for flies on the outskirts of the city. Board the *top-deck* and keep these birds in view—we may have time to learn something about their language. I daresay you know already that swifts can sound but *one* note, namely, a highly-pitched prolonged squeak. Observe these birds are clustering into a little party : now they are descending and are dashing past us at a terrific speed, and then onward around the eaves of that massive terrace of public buildings ? We all heard them squealing during this *manœuvre*. The note is usually sounded when they flock together, and I believe its simple language is that of a *call-note*, in combination perhaps with a very elemental sociable or choral expression of *song*. The swift has no need of an *alarm-note* ; he is master of the air in which he lives and moves and has his being. In adroitness and speed he can defy the swiftest falcon on the wing. We get a definite idea certainly that, when the birds dash through the air squealing, there is a strong element of rivalry in speed, and no doubt in other gymnastic displays on the wing. Transcribed ; their simple monosyllabic code might say : ' Away, you rivals, enter for the race, and test your speed on the wing.'

Now, my young friends, we must alight at the next stopping-place. Come along : off you go ; you know your way. Safe home.

In the next chapter we shall study the mechanism of flight.

LECTURE 10.

CHAPTER XVII.

THE MECHANISM OF FLIGHT.

Perfect adaptation—Body boat-shaped—Wing-bones strong—Fusion of hand-bones—Wing-muscles enormous and powerful—Characters of flight-feathers—Birds fly by skin-appendages—Reptiles and mammals by skin-expansions—Bird's ballast—Adjusting the centre of gravity during flight—Man locomotes mainly on a level plane—Centre of gravity easily adjusted—Balance may easily be upset—Why a bird cannot be capsized?—Comparison with an over-turned lifeboat—Why a bird cannot fly or float on its back?—Tumbler-Pigeon's somersault—Birds heavier than air—Increased and sustained momentum—Balloon and air-currents—The swooping falcon and gannet—Birds similar in size, often differ markedly in weight—Powerful wing-stroke of swans, geese, and other heavy birds—Flight and the atmosphere—The elasticity and compressibility of air—Travelling against a head-wind—Flying-bird supported by compressed air—Induced currents in rapid flight—The wing-stroke in flapping-flight—Spreading, folding, and rotation—Main object of down-stroke—Gathering in and holding the compressed air under the wings—Body supported and elevated—Down-stroke, a powerful muscular action—Wings fully spread—Tips supported on fulcrum of compressed air—Each wing a long lever-bar—Body at other end of fulcrum—Weight to be raised—Mechanism of the up-stroke—Passively performed for most part—Folding of wing—Elastic recoil—A pretty demonstration on a fresh dead bird—Flight-feathers raised and loosely over-lap—Escape of compressed air from under wings—Body falls during up-stroke—Curved path pursued in ordinary flapping-flight—Parachute descent—Other methods of descent—Flapping-flight and motionless glide—Alighting—Attitude of body—Duck alighting on water—Gannet arriving at a cliff—The inducement of maximum resistance demonstrated—Rising off the ground—Steep ascent—Attitudes assumed—Fanning the tail—Ascending-currents—Soaring alongside a cliff—Steamer's lively breeze—Gulls sail on motionless pinions—Mechanism of fluttering or hovering flight—Velocity attained by birds on the wing—Small garden-birds average thirty-five miles an hour—Pigeon, a mile a minute—Swallow, a mile and a half a minute—Swift, three miles a minute—Birds seldom travel at utmost speed—Adverse circumstances.

TRULY may it be said that birds are masters of the air. In our anatomical studies we have learned, among many other things, that the architecture of the avian body is exquisitely adapted for purposes of flight. We have advanced sufficiently in our knowledge to enable us to understand, nay more, to appreciate fully, several fascinating problems regarding the mechanism of flight, which will be unfolded in the pages of this chapter. Recall to your minds, in the first place, the advantageous boat-shape of the body ; the unique manner in which the bones of the upper limb are, in a large measure, welded together in order to impart strength and stability during the powerful strokes of the wing ; the immense size and power of the wing-muscles ; the shape, structure, curvature, and elasticity of the feathers, and the beautiful fashion in which they are arranged, overlapping like tiles on a roof, and thereby enabling the bird to present its body when flying as a compact mass to the air. Furthermore, recall to your minds the ease with which the long flight-feathers can rotate and separate like the laths of a Venetian blind, enabling the compressed air, when no longer needed, to be set at liberty from under the wings.

SKIN-APPENDAGES.

Birds are the only vertebrate creatures which fly by the aid of *skin-appendages*, in other words by feathers. Flying-reptiles and flying-mammals move through the air by the aid of *skin-expansions*. These membranous structures cannot be put to so great an advantage as wing-feathers. Again, remember that the heavy organs within the avian body are situated as close to the breast-bone as possible, in that way they are far removed from the suspension of the wings : the

latter therefore, together with the light-weight organs, are situated high above the centre of gravity. We very aptly compared the avian body to a boat, deeply keeled, and made steady with heavy ballast. (Fig. 34.)

HOW A BIRD MAINTAINS ITS CENTRE OF GRAVITY.

Here we must note at the outset that a bird, in moving through the air, is frequently called upon to shoot steeply upwards or to plunge headlong downwards, or perchance to turn sharply with marvellous speed and adroitness. To perform such wonderful feats it must have the power of rapidly altering and adjusting its centre of gravity to a nicety. This can be carried out, when the wings are expanded, by backward or forward movements at the shoulder-joints; by fanning and rotation of the tail (when the feathers are of sufficient length to permit of such action); by coiling and stretching the neck; by flexing one wing and rotating the head. The two last movements are adopted when the bird, by tilting its entire body, turns and steers a new course. It is true that sometimes we elect to climb a steep hill and descend again into the valley. These perambulations are but trivial variations in our terrestrial path compared with those which a bird in its aerial routes can effect. When we locomote, a slight movement forward or backward of the body, as a rule, will suffice to adjust the centre of gravity so that it may fall within the limits of its base of support. We sometimes over-balance, topple, and hurt ourselves. This mishap may take place apart from tripping over an obstacle, or slipping on ice, or other substances. We are called to alter our centre of gravity to a comparatively small extent, because, for all practical purposes, we are creatures who

move about in one plane, yet not infrequently we knock our balance out of gear ! Can a bird be capsized ?

A BIRD CANNOT CAPSIZE.

No ; because its balance is such that whatever be the caprices of the air-currents, and whatever position the wings may be called upon to assume, *flight is kept absolutely under control*. True, heavy gales might be held responsible for disaster by hurling the flying-bird against obstacles such as tall trees, buildings, or telegraph-wires, or by driving a weary traveller far out to sea, when sheer exhaustion ultimately sends it downwards to a watery grave. But given navigable weather (and there are many larger birds which can battle the tempest to a remarkable degree), a bird in the air, as far as its balance is concerned, may be compared to a compass set upon a gimbal. Let us once more lay stress upon the fact that in the bird the centre of gravity is capable of being neatly and extremely finely adjusted by various bodily movements. More important still, we should bear in mind that its body is so adequately weighted far below the suspension of the wings, that even were it possible for a bird to 'turn turtle,' that is to say to float for a moment breast-uppermost in the air, it would immediately right itself with the same ease as a capsized lifeboat would immediately turn keel downwards. *We* can lie on our back, move along after a fashion on our back as a gymnastic display, and we can also swim and float on our back. In aquatic displays we can easily rotate. Can a bird fly breast uppermost or even float in the air in that position ? No ; its boat-shaped body and heavy breast-ballast will not permit. Very few birds ever attempt, voluntarily, to turn a back somersault in the air ! Tumbler-pigeons have acquired the art — even

then this is often imperfectly performed—by long practice ; but as we watch the manœuvre we cannot fail to notice the rapidity and ease with which the *columbine acrobat* is actually called upon to right himself.

BIRDS HEAVIER THAN AIR.

It is obvious that all birds are heavier than air, or else a victim with a broken wing would not come to earth with such speed. In days gone by it was thought that the air, which naturally became heated in the air-sacks, including those sacks which line the pneumatic bones, reduced the bird's density sufficiently to enable it to rise passively, i.e., without the least exertion, indeed after the fashion of a balloon. It is now known that this is not true. The body-weight is no less in the air than on the ground, and the bird, in order to start, must exert its wing-power to a great extent. In other words the initial movement of flight demands powerful muscular action. Supposing that a bird were proportionately as light as a balloon, flight in its true sense would be defeated ; the bird would become a mere captive rather than a master of the air ; steering would become impossible ; the wind would decide ultimately the course pursued through the air, and then the poor hapless creature would drift aimlessly about in space. Neither a machine nor a bird as light as air could exceed a speed greater than the atmospheric current in which it were carried along. Yes ; it is essential that all birds should be decidedly heavier than the medium in which they fly. Otherwise they could never sustain the momentum which they gather when proceeding under way. A falcon could not shoot down like an arrow from a height on its prey, nor could a gannet precipitate itself with incredible speed headlong into the waves, if lighter than air. Even when a

bird is descending more gradually in gliding flight, it moves by virtue of its own gathered momentum, and, by almost closing its motionless wings, it allows itself to come to earth, to a great extent, by its own dead-weight. (Fig. 46.)

RATIO OF SIZE TO WEIGHT.

Different classes of birds, though approximately similar in size, vary in a marked degree in weight. A partridge is much heavier than a barn-owl ; a duck than a large gull ; a goose than a heron. A wild swan is very weighty, and your arm would soon grow tired if you were obliged to hold up this hefty bird by the legs for a short space of time. Is it not surprising at first sight to learn that a massive, heavy bird, such as a goose or swan, can fly with grace, speed, and buoyancy ? If we watch wild-swans in company rise from off the water, they certainly appear to get under way *slowly and laboriously*, and the powerful but measured strokes of the wings produce a rhythmic, swishing sound, which reminds us almost of the noise made by the cracking of the circus-trainer's whip. Continue to watch these ponderous birds until they have made a fair start, and you will then see that their majestic movements prove them to be masters of the air. In charming verse we read :—

“ So the white swans from the firmament swoop
With their gong-throated queen,—a beautiful troop—
Wheeling gracefully earthward, and floating as though
The young winds were wooing fair cloudlets of snow.”

How is it that these and many other markedly heavy birds can manage to support themselves in the air ? You remember I hope the opening remarks in the first chapter : “ It is far better when you see a bird in the air, to say, it flies because it has wings than to pass by without noticing its movements.

Later on, you will learn that the wings are only partly instrumental in enabling a bird to fly." It is particularly true in the case of swans, geese, ducks, partridges, grouse, and many other *heavy birds*, that their relatively small, short, wings are only *in themselves* the instruments in flight. Obviously in such birds the wing-strokes must *in addition* be particularly powerful and rapid, in order to raise the resistance offered by the air to a very high and almost continuous pitch. What do we mean when we speak of the resistance offered by the air? The answer to this question presents no difficulty if we constantly keep before us the fact that the air which we breathe, in other words, the atmosphere, exhibits (like other gaseous bodies) two well-known properties, namely: *elasticity* and *compressibility*.

ELASTICITY AND COMPRESSIBILITY OF AIR.

The air readily stretches or expands, and, just like *solid* elastic substances (such as rubber), in stretching, it becomes thinned out. Air in such a state is said to be rarified, and we know it occurs at high altitudes. With equal facility the air can be compressed, and a certain quantity or volume can be so reduced in bulk as to occupy relatively a very small area. Compression and expansion (correlated with variations in temperature) are of everyday occurrence, and are important factors which account for changes in the weather. When the air circulates or flows with great velocity, we learn something of the powerful resistance which it can offer if we insist on moving against current. Travel on foot or in a vehicle into the very teeth of a tempest and the resistance of the atmosphere may be sufficiently great, not only to bring your progression to a standstill, but even to lift you off your feet and hurl you back, so that it becomes necessary to rush for

the nearest shelter. The resistance offered by the air can also be appreciated on a *calm day* if one travels on the ground at a very considerable speed against the current. We all know that cycling or motoring at high speed, can become a most breezy business !

MECHANICS OF FLIGHT.

The mechanics of flight is a long study, presenting many difficult problems. Here, to avoid going too far afield, we shall confine our attention to some broad and general principles which will throw light upon the cogent question, namely ; how the air can be utilised so that it becomes a firm support in flight. It is easy to understand that if birds could manage to bring a volume of compressed air close up against the under surface of their bodies, a sufficient buoyancy would be maintained to counteract gravity. Furthermore, the greater the quantity of air collected and the greater the degree of compression, the more buoyant would be the flight. We are aware that compressed air possesses very great powers. Think of the velocity at which a pellet of lead will travel when the trigger of an air-gun is released ; or the force with which a cork, when not adequately secured, will fly out of a bottle containing soda-water. In both instances it is compressed air which acts as the momentum.

INDUCED AIR-CURRENTS.

When a flying bird gets well under way and is travelling at a very high speed, the current of wind, flowing in the opposite direction (for we must take it as a general rule that birds elect to travel head to wind whenever it is at all possible), offers resistance, and actually gives some support to the body as it flows close under the wings. This flow

is steady and constant, so long as the bird is travelling, and the faster the bird proceeds the more buoyant becomes its flight against the resisting air.

Indeed, in flight it may be said with emphasis that a bird travels largely on, and is given considerable support by, *a current of its own making.*

MECHANISM OF THE FLAP-CYCLE.

At this juncture in our studies, let us obtain a useful general notion of the mechanism of the wing-strokes during flapping-flight at a moderate speed, our bird being moderate in weight, and possessing the average-sized wings. At first sight we might think that the wings moved vertically up and down with little or no alteration in their spread. In reality the strokes are not by any means so simple, but include spreading and folding, in other words *extension* and *flexion*. In flapping, the wing can also be rotated, which is a most important movement, for it permits the under surface to turn through a right-angle and therefore to look *directly* forwards.

At the shoulder-joint, moreover, the wing can glide backwards and forwards, a useful piece of mechanism concerned with the adjustment of the centre of gravity.

Now what do you think is the main object of the beat of the wing? The compression of the air? Yes; that is right, in so far as you have attempted to answer, but here a fuller explanation is required to make the meaning intelligible. Let me supply the rest. During the down-stroke the outer part of the wing, with its stiff, unyielding feathers, seizes upon a great quantity of air which, when encompassed, is gathered under the wing and compressed against the body. In this way the buoyancy of the bird is sufficiently increased to enable it to derive adequate support during flight.

THE POWER OF RISING ON THE WING.

But the bird requires more than mere support ; it must have the power of rising. Here the rotation of the descending wing comes into play, because when the under surface is swept forwards, a barrier is obviously thrown across which holds up the compressed air under the wing and so prevents its escape from behind. As the body proceeds forwards, this pent-up air offers still further resistance ; its buoyancy consequently is increased, and the bird now mounts the crest of the air-column as a boat rides over the billows.

Remember that the down-stroke is a very powerful muscular action, brought about by exceptionally developed breast-muscles—muscles fully a hundred-fold more powerful relatively than the same in Man !

FULCRUM AND LEVER.

During the down-stroke, the wing is fully spread, and according as the stiff, resisting quill-feathers of the tip and outer part, continue to press more and more down upon the air, the latter ultimately gives such firm support that it actually plays the part of a *fulcrum*, which can elevate the weight at the other end of the lever, namely, the body of the bird. It is very interesting to think that in making the down-stroke, the wing partakes of the mechanical advantage of a lever. Here we certainly have a system, which I am sure many of you are familiar with as a *lever of the third order*, that is to say one in which the *power* is in the middle, the *weight* at one end, and the *fulcrum* at the other. Let us be perfectly clear : the weight to be raised is the body *at the inner end of the wing* ; the fulcrum or prop which helps to raise the weight is the compressed air *at the outer end of the wing* ; and the power (here

constituted by stupendous muscular action), *resides in the expanded wing itself, which is truly a long and most efficient lever-bar.* It is no doubt novel to think of a movable and highly compressible fulcrum. But think again! Air when compressed becomes a mighty, potent agent, and at the start the down-stroke of the wing must act with *tremendous force and rapidity* before the resistance of the air grows sufficiently strong to serve the useful purpose of a fulcrum.

MECHANISM OF THE UP-STROKE.

Next, a few words in regard to the mechanism of the up-stroke. This is for the most part passively performed, but not altogether, because there are definite muscles which help to elevate the wings, and which come into action at the end of the down-stroke, that is to say when the great breast-muscles have ceased to act. In a large measure the up-stroke is the necessary result of the active drop of the body. At the beginning of the up-stroke the wings are not spread; indeed they are sharply folded by the action of elastic ligaments, which, having been stretched when the wings were spread, now come to a position of rest. In short, the sharp folding of the wings is mainly due to elastic recoil, and is carried out so rapidly that it nearly always escapes observation, unless a bird be flying very leisurely.

A PRETTY DEMONSTRATION ON THE DEAD BIRD.

Here is a pretty demonstration: spread the wing of a fresh dead bird by traction on the flight-feathers with finger and thumb; then suddenly let go and, as suddenly, the wing becomes sharply folded. Recollect that during the up-stroke the flight-feathers are raised and, as a result, overlap very loosely; or they may be rotated, so that overlapping

is prevented, nay more, is now replaced by open spaces between adjacent feathers. What is the explanation of this delightful bit of wing-mechanism? Surely, to release the compressed air from under the wing during the up-stroke. By this mechanism the air is indeed thoroughly liberated from under the wings. It is at once obvious that folded wings, with their long feathers pointing upwards, could not possibly lay hold of, and hem in, a column of air. True, the wings tend to spread when the up-stroke is drawing to an end, nevertheless, the air, then encompassed, can still pass freely through the gaps between the rotated flight-feathers. It is not until the beginning of the down-stroke that the feathers, one and all, are tightened down and all the spaces are obliterated, thereby absolutely preventing the escape of air.

Having followed the flap-cycle of the wings, we are in a position to formulate definitely and say that the down-stroke is *actively* performed by powerful muscular action whilst the body as a result is *passively raised*; that the up-stroke is for the most part *passively* performed whilst the body as a result *actively* falls. The greater the size and length of the wing, coupled with the greater strength and speed given to the down-stroke, the greater the height the body will be elevated, and of course as a result, the greater distance will it fall when the wings are uplifted.

PATH OF FLIGHT CURVED.

In flapping-flight, birds with wings of this kind move along a path formed by a chain of up and down curves. If the body be not altered in position, this wave-like path is maintained at a fairly constant level from the ground.

What do you think would happen if a bird kept its wings raised above its back? By slightly spreading them it would

descend to earth nicely and slowly, like a parachute. Why slowly ! Because sufficient resistance would be offered by the air pressing on the under surface of the wings to prevent the bird crashing to earth.

What other methods might also be adopted should it wish to descend ? It can project its body in a downward direction, keeping its tail in line or somewhat elevated ! If



[From Herman and Owen's " Birds useful and harmful."]

FIG. 46.—A MERLIN'S HEAD-LONG PLUNGE

" On half closed wings, like ' a bolt from the blue '....upon its quarry."

it wishes to descend in flapping-flight, then its wings strike downwards and backwards, allowing the compressed air to escape behind immediately. If it wishes to descend on motionless wings, it flexes them to a varying extent and

Applying the Brake.



A.—GANNET ARRIVING ALONGSIDE A CLIFF.

"A very impressive sight.....poised as it were in the air for a moment in a plane quite perpendicular to the horizon."



B.—DUCK ALIGHTING ON THE WATER.

"You have seen ducks swooping down rapidly and then, as they were almost in the act of dropping on the water, reversing their position."

planes down, checking its fall by reversing its position before alighting. (Fig. 46.) In assuming this latter position, the head and body are inclined upward and forward, the feet expanded, the tail depressed and fanned, and the wings make short rapid strokes in a downward and forward direction.

MECHANISM OF ALIGHTING—MAXIMUM RESISTANCE.

I am sure you have seen ducks swooping down rapidly and then, as they were almost in the act of dropping upon the water, reversing their position as I have just described. By such a procedure the largest possible areas of the body and spread wings are presented to the air, thereby promoting maximum resistance. (PL. XVII. B.)

I have frequently observed gannets, when flying rapidly towards a very lofty, precipitous cliff, suddenly tilt their bodies to so great an extent, that the entire length of their breast and abdomen and also the under surfaces of their completely extended wings *faced the cliff*. It was a very impressive sight when great numbers of these hefty sea-birds, with their gigantic wings fully expanded, poised as it were in the air for a moment *in a plane quite perpendicular to the horizon*. Many of them even made a strong backward tilt, as though they had lost their balance and were about to turn a somersault backwards into the sea ! Here again the huge body and wing-surface presented to the air, induced maximum resistance, much intensified by the air-currents which were at the same time being reflected upwards from the cliff. (PL. XVII. A.)

We have seen that the down-stroke elevates the body. What would happen if the bird, having made the down-stroke, kept its wings spread vertically in the one position beneath its body ? Would it continue to rise ? No ; because the compressed air would soon escape from under the wings,

and while the bird might continue to travel for some distance on a breeze of its own making, this current would not give sufficient support ; hence unless the bird set its opened wings horizontally to enable them to encounter the resistance offered by the air, and thereby permit itself to plane down, it would certainly descend to earth at an extremely uncomfortable speed, over which it could exercise no control.

THE STEEP ASCENT.

When a bird wishes to make a *steep* ascent into the air, what must it do ? In the first place it must perform several *very powerful* down-strokes to raise itself quite clear of the ground. Then it must incline its body, including its neck, *steeply upwards* and carry its tail forwards, that is to say towards its abdomen, and then fan it. When a dog takes fright it lowers its tail and tucks it between its legs. Likewise the bird in rising carries its tail well forwards. During the down-stroke, the wings are carried further forwards than in horizontal flight. The position which a bird takes up when rising is similar to that which it adopts when putting on the brake immediately before alighting. In both instances there is such a large extent of the surface of the body presented, that resistance of the air is very much increased.

How then can the bird manage to rise in the one instance and yet descend in the other ? Note, during the ascent, the wings at once make *very long, powerful, and vigorous* down-strokes, which of course compress the air and hence elevate the bird. In descending against highly resisting air (and remember this is only for a very short distance above ground) the wing-strokes are *very short*, though still vigorous. These strokes therefore fail to compress the air sufficiently to keep the bird up, but at the same time they put on a sufficient



FIG. 47.—THE HOVERING KESTREL.

"Who has not watched the charming kestrel, poised over the corn-field or stubble, searching for mice, beetles, or grasshoppers !.... The little falcon appears as though suspended by an invisible thread : a motionless figure on outstretched wings !"

CHARMING TO WATCH.

WISE TO PROTECT.

Never forget that the kestrel befriends the farmer. Spare this attractive little falcon, and tell farmers, game-keepers, and others to do likewise. It is positively wanton and foolish to shoot a good bird-friend. Turn your back on this misguided policy.

brake to enable it to alight comfortably. Remember that the ordinary flapping-action of the wings, with the body horizontally inclined, would tend to drive the bird forward as well as upward, but since the air offers such greatly increased resistance to the very extensive surface presented at the start by the bird's *upwardly inclined body and fanned tail*, it follows then, that *onward* velocity is, for the most part, supplanted by *upward* velocity. An ascending bird makes it a rule to face the wind, and at times has the help of ascending currents.

ASCENDING CURRENTS.

We have often seen birds soaring on motionless wings alongside a steep cliff. Here, no doubt, advantage is taken of the air-currents, which, flowing in from the sea, strike the face of the cliff, and are then deflected upwards. In these ascending currents the bird soars in very graceful circles.

A lively breeze (at times too lively !) is induced by the steam-ship as she ploughs her way through the waves at high speed. In fine weather, however, we feel this breeze most exhilarating, and we derive great pleasure in watching the gulls alongside, sailing gracefully on motionless pinions, and at the same time looking eagerly for food cast overboard.

FLUTTERING FLIGHT.

Fluttering flight, unaided by up-currents for its support, presents a very different picture. The bird remains hovering in the air over one spot, and cannot travel on a breeze of its own making. Only by the most vigorous and extremely rapid wing-strokes can it 'pump' up sufficient resistance from the air to keep afloat.

Who has not watched the charming kestrel, poised over the corn-field or stubble, searching for mice, beetles, or grass-

hoppers? The wings beat so rapidly that the strokes can scarce be followed. The little falcon appears as though suspended by an invisible thread: a motionless figure on outstretched wings! (Fig. 47.)

VELOCITY OF FLIGHT.

Lastly, remember, velocity of flight varies very considerably. Our small garden-birds travel, on an average, at about thirty-five miles an hour. A pigeon, when put to it, can cover a mile in a minute. A swallow can add another half mile; a swift, at its fastest speed, can move at three miles a minute, but half the distance in that time is more usual.

Such then are the broad general principles of flight-mechanics. The knowledge we have gained will enable us to appreciate all the more fully the varied movements performed by the living bird on the wing.

In making such observations, our rambles by sea-shore, marsh, and hill-side, will be rendered thoroughly enjoyable, as we shall see when reading the next chapter.

LECTURE 11.

CHAPTER XVIII.

THE BIRD ON THE WING.

A DELIGHTFUL DAY WITH THE BIRDS ON THE BEACH, MARSHES, AND HILL-SIDE.

Birds closely related, fly alike—Exceptions—Value of body-weight—Headlong plunge of peregrine, duck, and puffin—Sand-flats abound in bird-life—Flight of shore-birds—Remarkable velocity—Glancing movements—Adroit turning—Buoyant flapping-flight of lapwing—Slow descent—Body small and light, wings very ample—Falcon on the scene—Rapid steep ascent of shore-birds—Downward dash to the water of ducks, geese, cormorants, and other heavy-bodied birds—Falcon in ascending outraced by shore-birds—The race for life—Can lapwing escape?—Too hard pressed to rise or descend to earth—Handicapped by its too ample wings—Cumulative momentum lacking for the downward plunge—Zig-zag flight to place of safety only hope—We repair to the marsh—Wing-movements of heron and water-hen—A magpie on the wing—Flight rather slow and feeble—Reasons—Some other short-winged birds, excellent fliers—Examples : grouse and partridge—Reasons—The strong steady flight of the rook—A word or two more about forms of flight before we reach the marsh—Gulls and terns—Very long wings, staying power, buoyancy, untiring energy—Flight of the albatross—Wings extremely long—Amazingly long gliding and wheeling movements—Humming-bird's faculty of hovering without growing fatigued—Wing-movements much too rapid to follow with the eye—The 'buzz' or 'hum'—We reach the marsh—Heron takes flight—Rises without effort and rapidly reaches a good altitude—Beat of wing slow and measured—Small body—Enormous wing-surface—Feeble momentum—Slow descent—Leisurely alights—Shallow wing-strokes prevent excessive rise and dip—In most birds

initial wing-strokes when rising are extremely rapid and vigorous—Some heavy water-birds paddle along the surface before getting under way in the air—Grouse o'er yonder hill-side—Flight swift and powerful—Heavy body—Small, strong, wings, very powerful stroke—Water-hen's clumsy start—Large feet dangling down—Flight fast and sustained—Flight of owl buoyant but rather slow—Feathers soft, wings ample, body light — Our enjoyable ramble comes to an end — Summary — Problem of flight — Associate weight, power, and velocity, with small wing-surfaces ; buoyancy, feebleness, and slowness, with ample wing-surfaces—In either case birds are heavier than air—Otherwise they could not fly—An aeroplane can fly ; a balloon cannot—Birds, masters of the air—Expressed in beautiful symbolic language, the bird is the air, " conscious of itself, conquering itself, ruling itself."

A WELL-WORN adage warns us that " a little knowledge is a dangerous thing." Here, however, we have no grounds for fear. The little knowledge which we have now acquired in regard to the mechanism of flight, can be applied with great advantage to our field-studies of wing-movements, in their numerous and varied forms. As a rule, birds closely related, fly much alike. Yet we must be prepared to meet with exceptions. For instance, in the family of *crows*, we find that the raven, the rook, the carrion-crow, the hooded crow, the jackdaw, and the chough, shew much the same wing-beat, which in the magpie is quite different. We shall see the reason presently. Again, the family of *gulls* is a large one : among the common species are included the great black-backed gull, the lesser black-backed gull, the common gull, the kittiwake gull, and the black-headed gull, all of which fly wonderfully alike. Their smaller *cousins*, the terns, also forming a large family, present a uniform type of flight. The swallow, the house-martin, and the sand-martin are so alike on the wing that a great many people fail to distinguish the one from the other. Members of the family of *ducks*, too numerous individually to mention here, are possessed of an unmistakably characteristic flight. The wing-movements of owls, when hunting, are very

different from those of falcons. This is a most interesting point ; we shall see the reason presently. All humming-birds, when hovering on wings vibrating at a stupendous speed, present the same deportment. Those hardy oceanic birds, the petrels, among which the albatross is a giant of the tribe, have a most distinctive mode of using their wings, though it should be noted that the miniature storm-petrel adopts markedly different wing-strokes. Lastly, most of our small land-birds cut much the same figure in the air. Here we should expect to find several exceptions, because many in this very large and diversified group are but distantly related. One might multiply several more instances, but space will not permit.

Let me remind you of a few fundamentally important facts which I laid great stress upon in the previous chapter. Firstly, all birds are distinctly heavier than air. Secondly, birds, approximately similar in size, may shew marked variation in weight. Thirdly, the air though invisible, is a substance which possesses mighty strength when compressed. When encompassed under the wings it can provide ample support for the moving bird. Moreover, when suddenly and intermittently released, the speed of flight,—acquired already by the cumulative momentum,—may be enormously increased in conjunction with the factor of gravitation.

‘ A BOLT FROM THE BLUE.’

No better example could be cited than that of a hawk precipitating itself on half-closed wings, like ‘ a bolt from the blue ’ headlong downwards upon its quarry. (Fig. 46.) Heavy-bodied birds, as we should expect, can descend with great velocity, and the power of carrying out this headlong plunge is not wholly dependent on any particular build of the wing.

The peregrine falcon with its strong, stiff, long-pointed wings, is considerably weighted, owing to the marked development of its massive shoulders and breast-muscles; yet this plunderer cannot on every occasion overtake the wild-duck in its precipitous plunge to the water, its favourable sanctuary. The duck's wings, whilst of moderate size, strong, and stiff, fall far below the mark in this respect when compared with those of the falcon. Furthermore, they are proportionately very much shorter. It is the heavy weight of the duck's body that saves its life on such tragic occasions. Puffins, razorbills, and guillemots, are heavy-bodied birds with small wings. I have seen them nevertheless at times outrace the falcon in their headlong dash from cliff to sea. Here again, in surrendering to gravity, the heavy bodies with which these familiar cliff-birds are endowed, may prove instrumental in averting a disaster.

A RAMBLE ON THE SAND-FLATS.

“Let's pretend” that, all of a sudden, we find ourselves rambling along low-lying extensive sand-flats, teeming with shore-birds. We are in great spirits watching the tremendous speed at which the redshanks and other species dash past. These birds possess moderate-sized, pointed wings, somewhat shorter than the average in length. As a class shore-birds are not strongly-built, but the exceptionally high speed at which their wing-muscles can act, allows them to cleave through the air at an astonishingly high velocity; they can turn and twist also in a most adroit manner. It is on these wing-movements rather than on the headlong plunge that they depend, when endeavouring to escape the enemy.

What are those black and white birds, collected into a little cluster, flying towards us? Observe the unusually

large size and rounded shape of their wings. They seem *all wings* and certainly their bodies are relatively very small. Their steady, flapping-flight, well-sustained, without hurry, indicates buoyancy.

THE LAPWING'S FLIGHT.

They also can twist and tumble with marvellous speed. They are lapwings. I fancy that some of you must have seen their active wing-manceuvres, accompanied by piteous screams of *pee-wit, pee-wit*, when their breeding-haunts were been approached. If the enemy be hot on the scent of the nest, the owners, one or both, may suddenly descend and alight at some short distance from their eggs or chicks, then rising again at a greater distance, endeavour to decoy away the intruders by their wailing cries and crazy gymnastic aerial performances.

Have you noticed the wing-movements of the lapwing when coming to earth? This bird descends in flapping-flight, or quietly planes until within a few feet of the ground. It then closes its wings and indulges in quite a short slanting glide until its feet are within reach of the ground. What is the reason for this mode of descent? Its body is too light in proportion to its ample wings to allow sufficient momentum to develop for the headlong plunge.

Quickly look up! We are now about to prove our point. The vast flocks of shore-birds are terribly excited; they have commenced to twist and swirl, and are pursuing a zig-zag path. Still more important, note they are flying rapidly upwards! Are the lapwings rising? Oh! indeed, yes, and very rapidly; their greater buoyancy easily urges them *upwards*, but it would not give them anything like

sufficient time to reach the ground and seek cover. Whatever is the matter ? Do you not see ? The falcon is on the scene.

A PEREGRINE FALCON ON THE SCENE.

Look ! all the ducks, together with a small party of geese and a couple of cormorants (which immediately before had been exercising their wings over the salt-water lagoon on your left), have shot down to the water in time. Now afloat, the falcon will hardly deign to molest them. Did you see that magnificent meteor-like swoop he made to the water's edge ? See him up again without his prey ! What a babel of voices now rends the air as the flocks, by their angry threats, endeavour to drive off the plunderer. The ducks and other swimming birds *pack closely*, keeping to the water, their sure haven. Some, more frightened than the rest, dive ; none, however, attempt to fly as long as the peregrine falcon lurks o'erhead. (Fig. 48.)

Can he come within close range of the multitudes of shore-birds which, in their mad excitement, pour down wrath upon his head, all the while pursuing a most zig-zag and fantastic path through the air ? See ! they never cease for one moment straining every nerve and sinew *to rise higher and higher* above the possibilities of the clutch of the dreaded talons. No, no ; the rapacious hunter may *shoot down like a meteor*, but he is not built to counteract gravity swiftly and powerfully enough to enable him to *shoot up like a rocket* in time to snatch up a single one out of the hundreds of birds which managed in time to reach their lofty safety-zone !

Bird-life however along these low-lying sand-flats is prolific, and the hungry plunderer will not allow himself to be thwarted.

THE FALCON'S TACTICS.

Just watch ! he has alighted on a dark seaweed-covered piece of old wreckage. Here his perfectly motionless figure and sombre plumage, blending with his pedestal, and partly veiled by the shadows cast upon the foot of the embankment, render him a sufficiently inconspicuous and innocent-looking object, to permit a stray solitary lapwing to approach in the direction of his vantage point. Judging accurately the handicap he could allow his intended victim, of a sudden he launches himself into the air and, on rapidly beating pinions, enters *on a race for life, he to destroy it, the hunted one to save it.*

THE RACE FOR LIFE.

Can the lapwing escape ? Alas ! we greatly fear that it is impossible. The victim is too hard pressed by the pursuer to attempt to avail himself of his buoyancy and rise. If this movement were attempted he would be obliged to slacken his speed, which would allow the hawk time to hurl himself against his prey and grab it with his terrible talons, even though the deed be carried out during an upward swoop. The hawk, with his stronger and swifter flight would accumulate a greater degree of momentum than that acquired by the lapwing.

ONLY RAY OF HOPE.

The only ray of hope which we could expect for the lapwing's escape would be that its remarkable powers of twisting and turning, if long enough indulged in, might take the bird on a path sufficiently zig-zag to delay capture, until cover be secured, or rescue from the pursuer be frustrated in some sort of way. The open ground would be no haven, nor could the lapwing reach it in time. The hawk would get there first. If the lapwing's path through the air were a straight

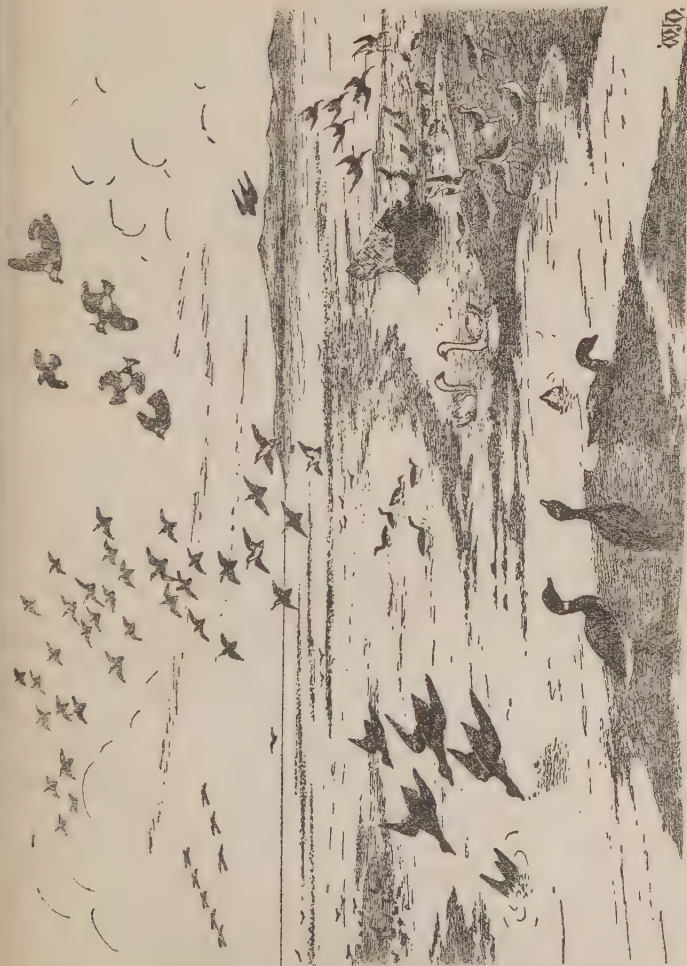


FIG. 48.—A PEREGRINE FALCON ON THE SCENE.

"Do you not see? The falcon is on the scene. Look! all the ducks....have shot down to the water in time....Can he come within close range of the multitudes of shore-birds?...See! they never cease for one moment straining every nerve and sinew to rise higher and higher above the possibilities of the clutch of the dreaded talons."

one, its fate would be sealed very soon after the race commenced. Moreover, the hawk endowed with much greater staying powers of flight than his quarry, could give the latter a very considerable start and in the long run effect a capture, provided no untold events interfered with the race.

From the foregoing observations, you will readily understand what a very important asset is sufficient body-weight to a bird, coupled with proportionate wing-power; on these factors depend cumulative momentum, without which aerial velocity could certainly not be sustained.

But for the lapwing's faculties of twisting and turning, its very ample wings and small body are, in truth, definite structural peculiarities which put restrictions upon powers of flight.

A TRECK INLAND TO THE MARSH AND HILL-SIDE.

Do you see that hill about a mile away? Come along, and hastily treck to the foot of it where there is marshy ground. We shall leave the seashore. We are almost sure to see a heron parading about in search of frogs, newts, or other aquatic creatures, suitable to its taste. I expect that you know the heron by appearance. He is a tall, sedate, and rather stately-looking bird, in deportment like the storks and cranes; in fact in some places he is commonly called the '*crane*.' This is however an erroneous name, for he differs in many details from the true crane. I fancy you have seen birds of this class in the Zoological Gardens, and also as stuffed specimens in museums.

In the same marsh we may be lucky enough to disturb a water-hen and put it to flight. Its wing-movements present a strong contrast to those of the heron, and it will be interesting to learn the reason. On the hill-side we shall more than likely get a view of some grouse. These birds also offer a marked contrast in flight to that of the heron.

A MAGPIE'S SHORT TRIP.

Hurrah ! there goes a magpie crossing the open field to your right. We have an uninterrupted view of his flight. Surely he seems a rather poor flyer ? His wings are short and he has to perform very rapid beats to keep up and make headway ; even then his speed is not swift. He is a species which seldom travels far on the wing. Observe him alighting on a branch of that large oak-tree near the edge of the plantation at the far end of the third field. Why must he beat his wings so rapidly to keep up and make headway ? Because by means of his short flight-feathers he cannot encompass and compress the air with the same facility as can a long-winged bird. Moreover, his short wings permit of less leverage than that obtainable by long wings ; consequently the fulcra formed by the resistance of the air give less support. This rule applies to all short-winged birds, but, in addition, we have to note that if the body be proportionately very heavy and the wings proportionately very small, the latter must then be wielded with immense velocity and power. If the flight-feathers be strongly built and resisting, and the wing-muscles powerfully developed, flight here becomes highly efficient, and we find small wing-surface and heavy body-weight are correlated with power and velocity. The heavy-bodied, small-winged partridge and grouse afford excellent examples. The poor magpie fails in power and velocity, because neither are his flight-feathers particularly stiff and resisting, nor are his wing-muscles particularly well developed. (Fig. 49.)

THE ROOK'S STRONG, STEADY, WING-BEAT.

Halt a minute ! Ambush yourselves by the side of the stone-wall : a party of rooks and a few jackdaws are about to pass close overhead ! Yes ; there they go. What a

splendid view we now have of their wing-movements ! Note, the beats of their wings are much slower compared with those of the magpie : at the same time note the birds move through the air much more buoyantly. Why ? Because their longer wings obtain more leverage and consequently more support from the resisting air. Can rooks gather much



FIG. 49.—ROOKS AND A MAGPIE ON THE WING.

" There goes a magpie.... Surely he seems a rather poor flyer?.... He is a species which seldom travels far on the wing.... The rook is.... strong and steady on the wing.... at times it takes great delight in seeking high altitudes appearing.... as a black speck in the sky."

momentum on the wing ? Yes ; their body-weight and wing-surfaces are well proportioned, enabling them to travel long distances, and to increase their speed considerably during ordinary flapping-flight. Moreover, availing themselves of their acquired momentum they have enough buoyancy and spread of wing to float or plane at times, thereby conserving

their energies by resting their wing-muscles. On the other hand, they have sufficient body-weight to descend to earth at a considerable speed should necessity arise.

The rook is a typical example of a bird, strong, and steady on the wing: by its twists and turns it can at times evade collision with the enemy, though its adroitness is inferior to that of the lapwing; hence when surprised at close quarters by the falcon, it is more speedily put to death. In making a steep ascent it is less buoyant than the lapwing and also than some other birds with long wings similar in build to its own. Nevertheless at times it takes great delight in seeking high altitudes, gradually appearing to the human spectator as a black speck in the sky. (Fig. 49.)

Let us once more bear in mind that *crows as a race*, fly in a similar fashion, except the magpie. Therefore the flight of these birds, in general, is strong and steady. It is uncertain whether we shall meet with a gull in this locality, along the country road, but you must all be familiar with its flight. It is not unlike that of the rook. I shall have time however, before reaching the marsh, to say a few words in regard to the graceful flight of this sea-bird, and the superb and unique movements of the giant albatross and the fairy humming-bird.

A WORD ABOUT THE FLIGHT OF GULLS.

I mentioned that all gulls fly remarkably alike. They move along with slow and measured beat of wing, and appear even yet more buoyant than rooks. The ratio of body-weight to wing-surface in the gull is hardly as well balanced as in the rook, hence the former whilst beating the latter in speed at air-climbing, cannot descend so rapidly. The gull however is very muscular, and despite its light-weight relative to its wing-surface, it can, after wielding several powerful down-strokes

glide on its gathered momentum at a fair rate against a strong head-wind. Gulls as a family, and their lesser relatives the terns, having longer wings than the rook, spend much more of their time in the air, and their untiring movements are full of beauty.

SUPERB WHEELING MOVEMENTS OF THE ALBATROSS.

But undoubtedly, the most exquisite aerial gyrations and other evolutions, *characterising flight in all its glory*, are performed by those birds with still longer wings relative to the size of their body. The mighty albatross, giant bird of the Southern Seas (whose enormously elongated, ribbon-shaped wings yield a spread from tip to tip of fourteen feet), can, after wielding a few stupendously powerful flaps, *skim, sail, or glide* on motionless pinions for a lengthened period, ever and anon wheeling, so that now his wings are set horizontal to the waves, now at forty-five degrees, now perpendicular as the mast of a ship. Such a monarch of the air, when once fairly under way, despite his body-weight of twenty pounds, can counteract gravity to such an extent that he is, in a large measure, self-supporting. The albatross is one of a large family of birds known as *petrels* (named after St. Peter from their faculty of *walking* on, really pattering along, the surface of the water with upraised wings), and nearly all of them are endowed with this superb wing-power. (Fig. 50, B.)

AMAZINGLY RAPID WING-STROKES OF HUMMING-BIRDS.

It is astonishingly interesting to learn that the tiniest bird in the world, the humming-bird, also is provided with very long, and narrow wings, which it uses in a very different manner, yet it displays at the same time equally wonderful

movements! So powerful are the wing-muscles of this avian lilliputian; so intensely rapid is their action, and so stiff and resisting are the flight-feathers, that the strokes are capable of extremely rapid movement, rendering them impossible to follow with the eye. The wings themselves, when vibrating, appear quite misty, filmy, or gauze-like.

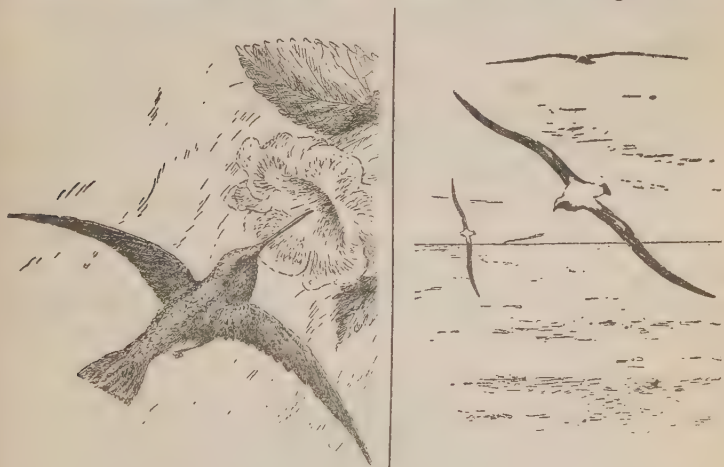


FIG. 50.

A.—HUMMING-BIRD HOVERING.

"The strokes are...impossible to follow with the eye...the wings...when vibrating, appear quite misty, filmy, or gauze-like."

B.—ALBATROSS WHEELING.

"Now his wings are set horizontal to the waves, now at forty-five degrees, now perpendicular as the mast of a ship."

Gravity is easily overcome, not simply because the tiny body weighs but a fraction of a dram, but rather on account of the very high resistance which the air offers to the extraordinary rapidly vibrating and markedly elongated pinions. (Fig. 50, A.)

Unlike all other birds the humming-bird can hover untiringly as it sips the sweet nectar or snaps up the juicy plant-lice from the blossom. While thus engaged, the stupendously

powerful and rapid vibrations of its wings, cause the highly resisting current of the air to emit a musically-toned *humming* or *buzzing* note.

In this suspended attitude the humming-bird maintains its body almost erect. After watching for a short while, we see it suddenly dart away (like an arrow shot from a bow) perhaps only ten yards off, perhaps a hundred yards, in search of another suitable flower. How did it travel so fast? Its wings did not appear to move. Why? Because the beats were too rapid to follow. Were they as rapid as when the bird was poised before the flower? No; for in the darting flight they produced no humming note.

Remember that in order to go forward, the little creature had to tilt its body from the perpendicular to the horizontal position, a matter of as much as ninety degrees! This very sudden and swift change of bodily position was effected by powerful action of the muscles, chiefly those of the back.

WE ARRIVE AT THE MARSH AND WATCH THE HERON'S FLIGHT.

Look! we have come along at a good pace, for there is the marsh a few yards ahead. Do not walk straight on to it. I am anxious in the first place that you should observe the heron from cover. Here is a nice peep-hole in the hedge. Ah! there he is, motionless, with his head sunk snugly between his shoulders. He is resting after a good meal and, as yet, our presence has not aroused his suspicion. Come to the gate, *post haste*, and then immediately wave your handkerchiefs. Look at him now with his neck stretched out straight to its fullest, *resembling a walking-stick*! What a remarkably long, slender neck to be sure! There! up he goes, rising without effort, *like an open umbrella carried off by the wind*!

Leisured Flight.



"You never saw a bird with wings so large for the size of its body? An extraordinarily good observation....We can quite understand that his immense wing surface renders him so buoyant that his movements in the air are performed leisurely."



THE HERON'S BUOYANT UPLIFT.

"There! up he goes, rising without effort, like an open umbrella carried off by the wind!....Watch! he carries his long legs straight out behind, and has again coiled his neck so that his head rests between his shoulders."



But Mr. Heron can go one better than the umbrella ; he can float up into the air on a very calm day. Watch ! he carries his long legs straight out behind and has again coiled his neck so that his head rests between his shoulders. (PL. XVII.) Look at the remarkable height he has risen in an incredibly short time, yet his wing-strokes are slow and measured.

Can he come down with the same speed ? Not by any means. Why ? You never saw a bird with wings so large for the size of its body ? An extraordinarily good observation ; moreover it is an indirect way of answering my question correctly.

THE HERON'S LEISURED FLIGHT.

We can quite understand that his immense wing-surface renders him so buoyant that his movements in the air are performed leisurely ; consequently he acquires very little momentum. He can float or glide down an incline leisurely, but, having little momentum behind him, he cannot plunge headlong with great speed. In making headway, in ordinary horizontal flight, it is actually desirable that he should be able only to work his wings slowly and that the beats should be as solemnly measured *as though they were keeping time to a metronome !* (PL. XVII.)

Just picture to your minds what would be the result if he were endowed with the faculty of wielding his surprizingly ample wings with immense velocity and power : why, a frail little boat, bobbing up and down on the troubled waters, now dipping into the trough, now surmounting the crest of the billows, would hardly make less headway than would our belated heron, who, poor fellow, would be forced to bob up and down in the air, as a tinselled fairy-ball drops and rises when suspended by a fine elastic string to a Christmas-tree !

Here is a delightful opportunity to apply that little, but not dangerous, knowledge which you possess in regard to wing-mechanism ! The heron has enormous wings and a very small body. What a super-abundant quantity of air then could he not collect and firmly compress were he empowered to beat his wings with immense rapidity and power ? Surely it is easy to understand that with each down-stroke, his relatively very light, small, body, would be elevated to such an unusually great height, and with each up-stroke would gravitate to such a depth, that it would be nearly impossible for him to make headway.

Let us definitely understand what is meant by *powerful strokes of the wings*. Mark you ! It means far more than powerful muscular action and elastic recoil, which are the two primary mechanical forces inherent in wing-action. It means, in addition, that the descending stroke passes through such an extensive aerial path that at its termination the pinions, as they face each other, *almost meet under the breast*, while at the termination of the ascending stroke *the extended wings meet and may even strike each other back to back*. The familiar banging sound, which pigeons at times make with their wings, is caused in this way.

Remember furthermore, that in order to release the highly compressed air from underneath the wings, very sudden and swift folding takes place at the beginning of the up-stroke ; and moreover that this release is expedited still further by the wing-feathers being raised and separated.

THE HERON'S SHALLOW WING-STROKES.

Supposing such extensive wing-movements as these were to take place *with great rapidity* in a bird with huge ample wings and a small body, it must follow that the rise

and dip of the latter would be inconveniently great to permit of other than slow and awkward progression. *Hence a heron is obliged to make shallow wing-strokes to enable him to proceed smoothly onwards.*

We noticed just now in the bird which we put to flight, that the wings in flapping, were carried only very little above and below the horizontal plane. There is no doubt that a heron is an extremely buoyant bird in the air; that goes almost without saying. This great buoyancy is the outcome of very ample wings and a small, light, body. Buoyancy was demonstrated immediately the bird took wing, by the manner in which it rose almost vertically from off the marsh, without the least exertion. Indeed its greatly expanded wing-surface virtually lifted it with ease straight away from off the ground.

Most birds are compelled to make very vigorous initial strokes of their wings when rising; swans, cormorants, and some other heavy birds, paddle along the surface of the water to create an air-eddy which enables them to rise.

It must now be plain to all of us that the heron is a slow and feeble flier, and if caught in a sudden gale, might fare badly, were shelter not available. In practice, however, it is likely that this bird exercises considerable prudence in judging the weather before embarking upon a perilous journey.

THE GROUSE SWIFT AND STRONG ON THE WING.

You recollect that the flight of heavy birds with small wing-surfaces is as a rule associated with power and velocity. Look up quickly at that grouse flying with rapidly beating pinions! How powerfully and swiftly he travels along the brow of the hill! Surely his form of flight quite accurately illustrates what I have just stated. Note his big, heavy,

body, and his small wings! I am more than delighted that this bird afforded us a demonstration of its type of flight.

Before leaving the marsh, be careful to keep a sharp look-out amongst those thick clumps of reeds and rushes which fringe the pond near the ditch to the right.

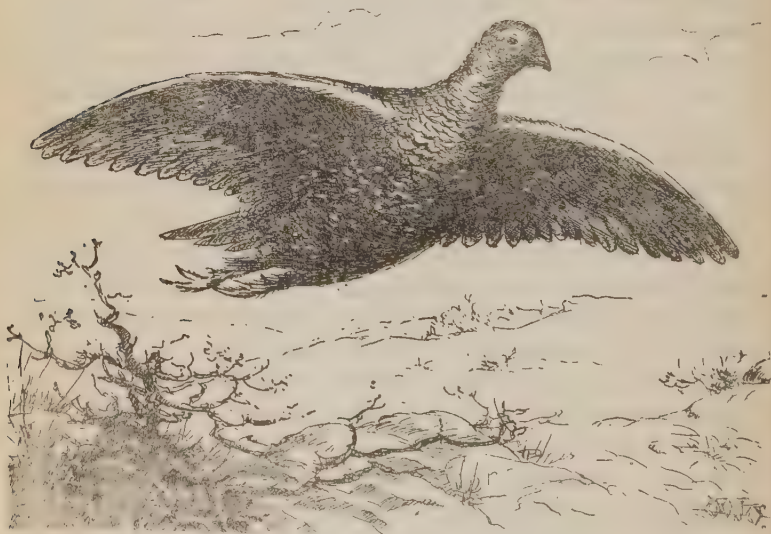


FIG. 51.—GROUSE SWEEPING PAST THE BROW OF A HILL.

"Look up quickly at that grouse flying with rapidly beating pinions! How powerfully and swiftly he travels along the brow of the hill!.....Note his big, heavy, body, and his small wings."

Ah! I thought as much: we scarce have had time to turn our attention to the spot before a noisy, spluttering sound has struck our ears!

THE WATER-HEN'S CLUMSY START.

A bird is just emerging from the rushes. There, look quickly! It is the water-hen taking wing! A clumsy, albeit most energetic performance! Observe the very quick and vigorous manner in which the wing-strokes are wielded! Why? Because here again we are presented with an example of a large-bodied bird trying to gather together and raise the resistance of as much air as possible by means of the strokes of its small wings. It is the case of the flight of the grouse over again. The latter, however, has the advantage of smaller feet, compact, short toes, and stiffer flight-feathers, which, coupled with the breeze which usually plays over the hill-side, enables this bird to rise from the ground more easily and in a neater manner. Indeed when the water-hen rises, its remarkably large feet and long toes dangle down parallel to the tall herbage to avoid entanglement. This preliminary position which the legs and feet assumes enhances the clumsiness of the initial stages of flight. (Fig. 51.)

When once well under way, both grouse and water-hen continue to flap their wings with power and marked velocity. Muscular wing-power in these birds of course is a positive gain, but in the heron, if developed proportionately, flight would defeat its own end!

Let me repeat: the heron is an example of a light-weight bird with very large ample wings; therefore its flight remains feeble and slow. Now you readily see what a sharp contrast is to be found in the form of the wings, the size of the bodies, and the style of the flight between the grouse and water-hen on the one hand, and the heron on the other hand.

We must of course bear in mind that there are many other birds, not necessarily related to the heron, with light bodies and

very ample wings, whose flight, as we might expect, lacks in a very large measure, power and velocity.

FLIGHT OF OWL AND FALCON.

The flight of the owl differs widely from that of the falcon. In the former the plumage (even including the flight-feathers), is peculiarly soft and yielding, allowing the night marauder, by means of his ample wings and small body, to approach leisurely, buoyantly and noiselessly, his slumbering quarry.

The falcon, on the other hand, gives chase by daylight to its quarry in the air, often initiating the pursuit by a prodigiously swift, downward swoop. In this bird-of-prey it is quite obvious that power and velocity, rather than buoyancy, are absolutely essential factors; hence greater body-weight proportionate to wing-surface, together with highly-resisting wing-feathers, are requisite. Along these lines the falcon is admirably endowed.

Now, my young friends, "let's pretend" that time is up, and that much against our will, we must wend our way homeward, having spent a whole long day in the open air; truly a delightful, health-giving day, and at the same time one in which we gleaned much information from the pages of the Book of Nature herself: yes, in truth, a day of high educational value to us all.

THE PROBLEM OF FLIGHT IN A NUTSHELL.

In conclusion let me emphasise that the whole problem of *flight* is associated, on the one hand with weight, power, velocity, and small wing-surfaces; on the other hand with buoyancy, feebleness, slowness, and ample wing-surfaces. In either case the bird is invariably heavier than air. So is an aeroplane: that is why it can be made to fly! Have

you thought of an aeroplane in that connection? A balloon is lighter than air. That is why it cannot fly!

Lastly, how fascinating it is to know that birds themselves take the greatest delight in their superb flight manœuvres during moments of leisure, just as an accomplished dancer or skater takes great delight in practising his beloved pastime. The graces of flight inspired Ruskin to symbolise the bird as: "Little more than a drift of the air brought into form by plumes, the air is in all its quills, it breathes through its whole frame and flesh, and glows with air in its flying like blown flames, it rests upon the air, subdues it, surpasses it, outraces it,—is the air, conscious of itself, conquering itself, ruling itself." I hope that some day you will all be able to commit to memory these delightful and ennobling lines.

Acquainted with the ground-work of flight-mechanism from the anatomical view-point, and with the manifold wing-movements observed in the living bird, we are in a strong position to investigate those amazingly long pilgrimages which birds can accomplish, and which constitute *migration*. This thrilling subject will engage our attention in the remaining chapters.

* * * * *

Postscript.—Formerly I wondered how it were possible for a puffin or razorbill to descend from a high cliff to the sea on upraised motionless wings in parachute fashion, seeing that the wings are so small proportionately to the heavy body. As an *a priori* argument it seems unlikely that the air could offer adequate support unless its resistance was higher than usual. We can argue *a fortiori* that this is the actual state. Because the strong *upcurrents of air so prevalent in such localities* must contribute largely in maintaining the buoyancy of the descending bird.

LECTURE 12.

CHAPTER XIX.

WHY BIRDS MIGRATE.

Bird's complete mastery of the air—Wonderful endurance on the wing — Primary factor — Velocity less important — Conservation of wing-energy — Sailing, gliding, planing — High speed reserved for emergencies—Many species make lengthy voyages through the air—The bird's 'joy-ride' a pure delusion—Migration a very serious undertaking — Manifold dangers *en route* — Casualties sometimes heavy and wide-spread—Why are such risky journeys undertaken?—First consideration—Prodigious appetites—What some birds can eat *per diem*—Amazing statistics—The bird's life—Intensely bright and glowing fire—Stupendous energy and emotion—Keen competitors for food—The increase of bird-population—Spread of species over the Globe—Food question grows more difficult—Purely insectivorous birds—Food shortage in winter—Movement south from British Isles and other countries necessary—The descent of birds from northern regions—Lack of food—The snow-mantle—Loss of daylight—Our Isles visited in winter by vast numbers of birds which depart northwards in spring—Return movement of insectivorous birds—No food shortage—The instinctive flight for 'home'—Summer-Migrants strictly Summer-Residents, which return north to breed—Insectivorous birds enjoy life of continuous summer sunshine—Never breed in their southern quarters — Visitors, not residents, to such regions.

HAVING learned that the power which resides in the wings is undoubtedly stupendous, surely it is now expedient that we should turn our thoughts to migration. Several chapters must needs be allotted to the elucidation of this engrossing, yet comprehensive subject. It will become quite evident, as we proceed with our studies, that such a claim is fully justified.

Here and there we shall find ourselves face to face with knotty points and difficult problems ; nevertheless the story is fascinating and full of thrills.

The knowledge already acquired in regard to *flight*, will go a very long way in helping us to understand how it has come to pass that birds can accomplish such amazingly extensive journeys without being overtaken by fatigue. We shall see presently, that owing to valuable researches, made within recent years, much can be explained in this direction. Nevertheless, we cannot at the present day refrain from wondering at the vast migrations which many of our frail and fairy forms embark upon and successfully accomplish. We cannot but marvel at these little feathered voyagers, as they forge ahead with undiminished vigour, more especially during the hours of inky darkness. But, with a view of throwing light upon these wonderful feats in travelling, recall to your minds the fact that the muscular mechanism of the wings is developed to an extraordinarily high degree, thereby allowing of the possibility of most astounding endurance of flight.

ENDURANCE OF FLIGHT MORE IMPORTANT THAN VELOCITY.

We know, beyond dispute that velocity in flight is most remarkable in some birds, and moreover that it is a great asset ; nevertheless, it remains a feature of secondary importance when compared with endurance. Were birds not endowed with astonishing endurance on the wing, it follows that they could never be permitted to undertake successfully vast journeys without a break.

Again, I shall ask you to recall to your minds those very varied forms of flight, those truly wonderful figures which birds can cut in the air. Keep the fact fresh in your minds that birds often sail, glide, or plane, on motionless pinions. Then

consider what an advantage these faculties must be to the migrant when it is confronted with muscular fatigue? What a beautiful adaptation is here presented for conserving wing-energy! Remember furthermore, that the voyagers take care not to expend their utmost velocity throughout their entire migratory movements; it is vitally important that the power of putting on extra speed should be reserved in case of contingency. Just think; how diminished would become the chances of reaching the goal if a migrant, pressing forwards in an exposed situation, say along the coast or perhaps even out at sea, fell in with a bird-of-prey, or if it were threatened with boisterous weather. On such and other adverse occasions our little feathered traveller must be vigorous enough to speed up, in order to seek refuge at the nearest possible haven.

FLIGHT A POPULAR STUDY.

Remember also, it is only within a comparatively recent date that the marvels of flight in birds have been fully appreciated; this special department of study has now become much more popular in association with the development of the mechanics of aeronautics.

Man has at last conquered the air in so far that he can sit in a machine and fly it with a considerable degree of efficiency and also reliance. Such a wonderful achievement must certainly have imbued many more persons than formerly with immense interest regarding several problems of bird-flight. Those of us who have had the opportunities of locating ourselves at favourable observatories, notably at light-stations along the coast, and have at the same time sedulously attended to the subject of migration, have no doubts whatsoever regarding the ability of birds of many kinds to undertake lengthened journeys.

Feeling therefore firmly convinced that birds can travel far and wide, might it not occur to some of us, on first thoughts, that our little feathered friends might resolve to set out on their travels purely for pleasure? Aye, indeed; might we not pronounce our little feathered friends actually lacking in enterprise were they not to avail themselves of their unsurpassed powers of locomotion for seeing the world? Looking, however, below the surface of the question, we must view the purport of migration in quite another light.

Ages ago the ancestors of our living species of birds were most likely much more limited in their powers of flight. Indeed some observers lend favour to the view that amongst the earliest feathered forms, flight had then but feebly or perhaps not manifested itself, and that perhaps the ostrich, and other flightless birds of the present day, may represent survivors of ancestral types.

THE 'JOY-RIDE' A DELUSION.

No; birds did not acquire the power of flight in the first place to allow them to trip hither and thither on a mere 'joy-ride'! Indeed, far from this being the case, there are very cogent reasons for regarding migration as a purely business transaction: nay more, it is often fraught with grave perils, and sometimes hundreds of the voyagers are lost *en route*. Of a truth we may say that migration is not the enviable gift of Nature which has been sung by the poets. Why then, we ask, do birds migrate if they have, so to speak, to take their lives to such a great extent in their own hands? I know that you are all very keen to hear the answer, but it will be more instructive, and in the end give much more pleasure if, step by step, we try to unravel what seems at first sight a great mystery.

WHY DO BIRDS MIGRATE ?

Yes, indeed ; why do birds, especially our frail, fairy-like forms, embark on perilous journeys ? Why, for instance, will the tiny goldcrest (whose body is little bigger than that of a humble-bee and weighs but a dram), set out in the dreary days of November to cross the North Sea, especially when we bear in mind that a considerable part of the journey is made during the hours of darkness ? Why should black-birds, thrushes, starlings, robins, chaffinches, and other species familiar to us as garden-companions, relinquish our lawns and cultivated fields where—judging from the amount of worms, etc., which we actually know are consumed,—food is abundant and shelter is available. But here, we only obtain, stray glimpses for the most part, of the wonders of bird-life. It is difficult for us to realise the vast amount of food a bird requires *per diem*. Let me impress this matter upon your minds by quoting a paragraph from the opening pages of the first chapter.

“ When you see your pigeons gobbling up the grains of corn, ... It is far better to say ‘ I am really ashamed of my pets for being so greedy,’ than merely to scatter the corn and take no notice of their ‘ table manners,’ Later on, when you study very carefully the marvellous machinery of their body, you will learn why it has become absolutely necessary, not only for your pigeons, but also for all birds to have immensely hearty appetites, without being in any sense greedy.”

We have already learned, among other things, that the machinery of the bird’s body is so constituted that it demands very rapid digestion and an enormous appetite.

HEARTY APPETITES AND STARTLING STATISTICS.

Let us cite one or two startling statistics ! A small bird, in one day, will consume food amounting to one-sixth of its body-weight. Just think ; a person weighing twelve stone eating two stone of food *per diem* ! More remarkable still is the case of nestlings which, in twenty-four hours, eat food amounting to their entire body-weight ! A young robin can dispose of fourteen feet of worm in twelve hours, probably more if it could get it ! But why have birds such enormous appetites ? Recall to your minds that when compared with Man or any other mammal, their heart beats much quicker and the blood is much hotter and flows much faster ; consequently the digested food-stuffs enter, and the waste products leave the blood-stream far more rapidly than in the case of mammals. Again, recall what I have said by way of illustration, in the first chapter.

THE GLOWING FIRE.

“ When coal burns very swiftly, giving forth a brilliant, glowing heat, we all know that it is necessary to stoke up the fire repeatedly. The living body of the bird may be compared to a swiftly-burning, glowing fire ; the large and oft-repeated consumption of food to the stoking of the fuel or coal.”

Birds are creatures brimming over with energy and emotion, creatures in whose bodies the fire of life glows so brightly that an incessant search for food must go on to provide ‘ *coal* ’ for the fire ; consequently birds are endowed with immensely large appetites. In this way it is easy to understand how very keen must be the struggle for a livelihood ! Moreover, as time rolled on, species grew more numerous and spread themselves more widely over the face of the Globe, so that the search for food became an increasingly serious problem.



FIG. 52.—SUMMER.

"Purely insectivorous birds, if they attempted to remain in our Isles all the year round....would most certainly become starved out in winter."

IN QUEST OF FOOD.

Let us now ask ourselves a highly important question. Can we, at the outset, establish an appropriate classification of birds according to their preference for certain kinds of food? Yes, this can readily be done. In the first instance consider the case of the small land-birds more particularly. Very large numbers subsist almost entirely upon insects. Bird-fanciers call the members in this order, in popular parlance '*soft-billed*' or insectivorous birds. Swallows, swifts, martins, fly-catchers, nightingales, blackcaps, whitethroats, willow-warblers, and several other well-known species, afford us examples. Furthermore, it is on winged-insects such as gnats, flies, etc., that these birds mainly make their diet; and as very large numbers of such insects die off before the winter, and others hibernate in nooks and crannies where their capture is not feasible, it at once becomes obvious that purely insectivorous birds, if they attempted to remain in our Isles all the year round (and this applies to our latitudes elsewhere), would most certainly become starved out in winter. (Fig. 52.)

Such birds seek warmer climes at the approach of our winter, migrating to tropical or sub-tropical regions, where insect-life abounds throughout the year.

But we may go further and say that several more soft-billed birds, such as robins, larks, blackbirds, thrushes, and others, which partake of a somewhat mixed diet, comprising insects, worms, grubs, snails, and berries, cannot always find a sufficient supply of this pabulum, and hence they are forced to migrate from time to time.

There is another large order including birds which feed mainly upon ripe grain and seeds, and the members are designated '*hard-billed*' by bird-fanciers. They have conical beaks, which are certainly very much stronger than those

of the insectivorous birds. Finches of various kinds, including our familiar chaffinch, greenfinch, linnet, and sparrow ; also corn-bunting, and yellow bunting, afford examples. In the harvest-time these birds have *great feasts* upon the ripening grain, but the harvest soon comes to an end, and, with the approach of winter, when many kinds of seeds are not procurable in sufficiently large quantities, a move becomes necessary. Some of these species are found spending the warmer parts of the year in countries *far to the north of the British Isles*, where the question of obtaining sufficient food in the winter would be more serious than for such birds remaining in our latitudes.

SCANDINAVIAN VISITORS.

Therefore, we find Scandinavian chaffinches, greenfinches, and other seed-eating birds, visiting our Isles during winter. Blackbirds, thrushes, larks, and starlings, which partake of the mixed diet already mentioned, also follow suit. Several of these familiar garden-birds leave us again in the warmer season and return to their nesting-sites high up in Norway and Sweden. On this very interesting point we shall have more to say presently. (Fig. 53.)

But there are yet two other fundamental reasons why land-birds of high northern latitudes *must* move southwards in winter. Firstly, they must retreat before the wide-spreading mantles of snow which, over large areas, become converted into solid ice-fields and hopelessly entomb their

THE DARKNESS AND RIGORS OF THE ARCTIC.

sustenance ; secondly, these birds would experience such serious loss of daylight that the search for food (even if a meagre



FIG. 53.—WINTER.

"We find Scandinavian chaffinches, greenfinches, and other seed-eating birds, visiting our Isles during winter. Blackbirds, thrushes, larks, and starlings....follow suit."

supply were obtainable), would be rendered almost futile. It is obvious that land-birds are affected most seriously by these adverse conditions ; nevertheless the more hardy shore and sea-birds, (even if they were able to obtain food during their perambulations along the sand-flats and among the sheltered creeks and estuaries where a milder climate prevails), would have to push southwards in search of longer daylight. Curlews, lapwings, golden plovers, grey plovers, ringed plovers, redshanks, greenshanks, and a whole host of smaller sandpipers, are examples of wading or shore-birds, while several species of ducks, geese and swans, are examples of swimming birds, all of which reach our Isles in winter in vast numbers, after having journeyed from more northern latitudes.

THE RETURN OF INSECTIVOROUS BIRDS FROM THE TROPICS.

Pursuing the subject of food-supply a little further, we may now ask why do purely insectivorous birds, which leave us in the autumn and travel southwards to more sunny climes in search of a livelihood, return to us so regularly and punctually in the spring ? It cannot be a question of seeking for food, because insect-life is abundant the whole year in tropical and sub-tropical regions. In the heart of the Tropics there is no such thing as winter and summer : seasons of the year are only classed as wet or dry. Day and night are of equal length or vary very little indeed at any time of the year.

In answering this question we had better here arrange our migrants into two sets ; firstly those which do not proceed beyond the Tropical Zone ; and secondly those which travel so far distant that they penetrate into the temperate areas of southern latitudes. The first set, on reaching their quarters

at a time corresponding to the onset of our winter-season, would be presented with a purely tropical outlook. They would find food in abundance all the year round ; they would enjoy bright sunny days (barring the rainy season, which they could temporise by taking adequate shelter) ; they would have plenty of daylight which would allow them to obtain sufficient food to satisfy their daily appetites ; excellent nesting-places would be available, and so the young broods need never lack and suffer hunger ! What then is the inducement, in the face of all these favourable conditions of life, for these insect-feeding birds to leave such a paradise, and risk a journey of considerable length, extending from North or Central Africa to the British Isles ? The answer to this riddle is delightfully interesting. We can furnish a two-fold reason by way of explanation.

RESIDENTS OF THE TROPICS.

In the first place the tropical birds proper (that is to say those which remain in the Tropics year in and year out), whilst tolerating a visitation of hordes of full-grown birds for part of the year, might strongly object to their countryside being too thickly studded with nurseries of baby-broods. The true natives might instinctively fear that their numbers might be over-run by an alien population ! Hence it is conceivable that they might give their visitors a time-limit, and then, should they not depart, clear them out before they contemplated building their nests. Interesting however as may be these facts, we must regard them in a most tentative manner. We have not sufficient evidence to warrant us asserting positively that the native tropical birds are unduly aggressive to their visitors at any special time of the year.

THE MIGRANT'S TRUE HOME.

In the second place (and undoubtedly here we learn absolutely the reason), we must always bear in mind that the true home of the bird is the land where it was born, and where in turn, when grown up, it makes its nest, lays its eggs, and rears its offspring. Therefore our insectivorous summer-birds, which come to us in spring, breed in our midst, and leave us in autumn for southern lands, return year after year, impelled by a strong instinctive desire to reach the old homes, the old spots so hallowed, where love, courtship, and wedlock, had their origin.

But as time rolled on, bringing with it changes in *geographical distribution* (with some species restrictions, with other species extensions), it is obvious that the 'old home' could not for all time be represented in every instance by the identical spot in a district, nay, even a county or a country! We can say however, without fear of contradiction, that the home lies somewhere within the confines of Temperate Europe, extending in the case of some species to sub-arctic lands! To their home, then, in Temperate Europe (wherever it may be located), these summer-birds wend their way in spring with utmost zeal. There is however evidence which lends favour to the view that some individuals return to the same district, even to the self-same nesting-site year after year. The swallow is a notable example.

SUMMER-RESIDENTS.

It is erroneous to speak of swallows, swifts, martins, flycatchers, nightingales, blackcaps, whitethroats, and many other insectivorous species simply as *summer-visitors*. These birds, strictly speaking, are natives and indigenous; in other

words they belong to our Isles, and, speaking generally, also to Temperate Europe ; but they are birds which through lack of food must perforce migrate to Tropical or Sub-Tropical Africa for a period covering our winter-season. To explain the to-and-fro movements tersely, we may say that these birds leave their native lands in autumn in search of food, and return in spring when it is obtainable.

These interesting *summer-birds*—many of them the sweetest of songsters—have a very busy time : building their nests, hatching their eggs, and feeding their youngsters ; because we must bear in mind that two and three broods are usually produced in the breeding-season, which extends from May to August. Surely then the so-called *summer-migrants* (migratory in their habit we must admit) can lay strong claim to rank as '*natives of the soil*' : *in other words they are summer-residents.*

SOUTHERN QUARTERS BEYOND THE TROPICS.

Let us now turn our attention for a moment to those insect-feeding little birds which, on leaving us in autumn, penetrate into the Temperate Zone of the Southern Hemisphere. Some travel as far as the Cape of Good Hope ; others beyond ! On reaching their new quarters, will they be presented with a purely tropical outlook ? Will they find food in equal abundance all the year round ? Will they have continuous warm weather and adequate daylight for feeding-purposes all the year round, and will desirable nesting-places be available ?

In replying to these questions briefly, it is evident in the first place, that these birds would not be presented with a purely tropical outlook, because their extensive migrations would bear them away to latitudes where there are distinct

seasons, that is to say appreciable differences in temperature and length of daylight, according to the time of the year. However, as the most southerly regions of Africa correspond in latitude to those European countries which fringe the Mediterranean Sea, it is evident that the migrants in their southern quarters, (even were they to arrive in the winter-season), would enjoy warmer and longer days than those prevailing in the winter in the British Isles. Hence in their southern quarters they would have quite sufficient food, light, and warmth, for their needs. Moreover, in South Africa the amount of insect-life procurable would not fluctuate to a serious degree; hence the question of paucity of food in winter need hardly be considered. Lastly, suitable nesting-sites would be available in a large measure.

But at this juncture a problem is presented of exceptional interest! Let me put it in the form of a question. Do those birds which leave us at the approach of winter and journey to South Africa really reach their destination in the winter? Just think! They pass beyond the Equator and penetrate for a considerable distance into the Southern Hemisphere. Now we have the clue; this simple problem is solved.

We all are familiar with the fact that when it is winter in the Northern Hemisphere, it is summer in the Southern Hemisphere. Surely, then, our feathered travellers, having spent the summer with us, leave at the approach of winter, not to spend a milder winter abroad, but actually *to enjoy another summer!* Yes; it is wonderful to contemplate on these travellers who depart from us, having left a summer behind them (in other words having enjoyed a summer) and arrive with the prospects of another summer before them!

HAPPY CREATURES OF THE SUN.

To these happy little creatures of the sun, winter, with its dark, short, dreary days, is a thing quite unknown. Yes, it is not in winter but in summer that the visitors reach South Africa. They have never to reckon even with that slight diminution of insect-food which would be presented during an unusually cold South African winter. Here let us repeat the question with still greater emphasis: What then is the inducement, in the face of all these favourable conditions of life, which prompts these insect-eating birds to leave such a paradise and risk a markedly protracted journey, extending this time from South Africa to the British Isles, and, for many individuals, far beyond? Here it is evident that the problem appears at first sight more subtle than in the case of visitors to the tropical areas, because in the more temperate climes there would be less interference with nest-building. Why? Because the native African birds, in countries outside the Tropical Zone, are less sedentary than those confined to the Tropics. Many of the birds native to South Africa, that is to say, which breed in the Southern Hemisphere, are themselves migratory to a certain extent, and move northwards towards, though not as a rule across, the Equator at the approach of the southern winter, and back again to the southern limits of the African Continent at the approach of the southern summer. At that season a wave of the feathered tide, consisting of birds native to both Hemispheres, would flow towards Cape Colony, the natives of the Southern Hemisphere, for breeding-purposes; those of the Northern Hemisphere for feeding-purposes: the former *natives of South Africa*, the latter *visitors to South Africa*. Thus the native birds of South Africa, being active and migratory themselves, would probably shew but little

hostility should our migrants from the Northern Hemisphere which arrived with them, start to build nests and rear families. It is the thoroughly stay-at-home tropical birds which might naturally guard their breeding-territories with keen jealousy.

NATIVES OF NORTHERN HEMISPHERE PURELY VISITORS TO
SOUTHERN HEMISPHERE.

So now we see that beyond the Tropics, right away down in the Southern Hemisphere, our migrants from the Northern Hemisphere which visited these lands, probably could have established their nurseries in friendly relationship with the native birds.

Have such breeding fraternities been established? No. Our swallows, swifts, martins, flycatchers, nightingales, black-caps, whitethroats, willow-warblers, and many other well-known species of insectivorous birds which come to our Isles and breed in summer (hence are summer-residents), must be looked upon purely as *summer-visitors* to the Southern Hemisphere, where they sojourn during our winter months.

ETERNAL SUMMER.

Surely then we can say these birds enjoy a life of continuous summer. Nevertheless, remember their true home is in the Northern Hemisphere, where they were born, and in turn where they now make their nests and have their families. To lands in this Hemisphere they naturally shew an overwhelming instinctive desire to return: and indeed the journey to our Isles, and elsewhere northwards, is performed in the spring with almost feverish haste.

“Why homeward turn thy joyous wing?
In a far-off land I hear the voice of spring
I found myself that moment on the way
My wings, my wings, they had not power to stay.”

In carrying out such migrations, birds vary considerably in regard to their geographical distribution. This, occurring among individuals of a species, no less than among *genera* and *families*, makes the subject of distribution comprehensive and very interesting. It will form the main topic of the next chapter.

LECTURE 13.

CHAPTER XX.

OUR SUMMER-BIRDS AND THEIR GEOGRAPHICAL DISTRIBUTION.

WARM WELCOME TO SWEET MINSTRELS AND BENEFACTORS.

Wide variation in range of travels—Among different species—Among individuals of the same species—Extensive Geographical Distribution in longitude and latitude, general — A few examples — Swallow's migrations to Ireland, Great Britain, the European Continent eastward to Russia—Far-Eastern distribution of our familiar and abundant spotted flycatcher—Amazingly extensive breeding-distribution of sand-martin—Distribution of its southern migration extensive in longitude, restricted in latitude—Many other common British summer-birds, too numerous to mention, widely distributed during the breeding-season—British summer-birds with a restricted distribution—Typical example — The nightingale — Breeding-distribution of this songster in Great Britain and on the Continent restricted in latitude and longitude — The arrival of summer-birds in our Isles — A most cordial welcome—Glad heralds of joyful events—Their advent symbolic of sunshine, foliage, blossom, and music—Warblers, a grand pageant of the Spring—Sweetest minstrels of the feathered world—Elegant and dainty in deportment—Fascinating studies in courtship—The home and the family—Swallows and their broods, an entrancing sight—The rough, rasping night-call of the corn-crake ; the mellow, mystic, fluting pipe of the cuckoo ; and the screaming swift, unsurpassed and untiring on the wing ; all gladden the heart of bird-lovers—To all summer-birds a hearty welcome.

BEARING in mind the main theme of the last chapter, we are now in a position to understand readily that migrants when travelling northwards in spring are *homeward-bound*, their sole business being, directly they reach their destination, to propagate their species. On the other hand, migrants travelling southwards in autumn are *outward-bound*, their business being to reach a destination where they may obtain adequate food and suitable climatic conditions during their sojourn. Remember, wherever the outward-bound travellers may, so to speak, '*pitch their tent*,' they must always be ranked purely as *visitors*, which quit their homes for a period covering our winter months. This to-and-fro movement has now become regular, we may say rhythmic, and it constitutes the essence of what we understand by the term *regular bird-migration* as it affects the *Northern Hemisphere*. In the case of birds which *breed* in the *Southern Hemisphere*, the state of things is reversed. Later on I shall have more to say on this point.

Some of our home-bound birds set out from the Tropics ; others away down from the Southern Hemisphere. In either case it makes no difference in regard to the purport of their travels : they leave their home in the Northern Hemisphere when the breeding-season is over, and back to it they return when the breeding-season comes round.

GENERAL RULES REGARDING 'FLY-LINES.'

Speaking generally, European birds (here we mean birds which breed in Europe), visit Africa ; Asiatic birds visit India, China, and other countries of the Orient ; and Canadian and North American birds visit Central and South America. Mark carefully that I adopt the word *visit* strictly in connection with the outward-bound movements. It is rare to

find an American *land-bird* crossing the Atlantic and visiting Europe or Africa, or to find a Far-Eastern Asiatic bird crossing by an overland route and visiting these Continents. However, some birds which journey far northwards, are distributed in the breeding-season all round the Arctic Regions. Such birds are said to be *circumpolar* in their distribution. Other species, including visitors to our Isles, in travelling southwards, spread themselves far and wide over the Continents of both the Old and New World.

WIDE VARIATION IN GEOGRAPHICAL DISTRIBUTION.

But let us now confine our attention to an analysis of the *geographical distribution* of some familiar birds which make the *British Isles*, among other countries, their homes in summer. There are many such species, and it is interesting to note that the extent of their travels northwards varies very considerably. Some stop short before reaching our latitudes, others pass on, penetrating into Iceland, Scandinavia, and Northern Russia. More interesting still is the fact that a given species even may be very elastic in its geographical distribution. Thus some of our swallows come to a halt in countries south of the British Isles, others in our Isles on in similar latitudes of Continental Europe, while others again proceed northwards to Sub-Arctic Russia and Scandinavia. Furthermore, this familiar and favourite bird, in travelling northwards, spreads itself widely over the European Continent, which means that in longitude as well as latitude it has an extensive geographical distribution. Thus, swallows abound in Ireland, Great Britain, and, on the Continent, eastward to Russia, in our summer-season. The majority of our common *summer-migrants* distribute themselves widely over Europe ; the British Isles being as a rule very

Energetic Travellers.



A.—SPOTTED FLYCATCHER.

"Some of our British birds....penetrate far eastward into the Asiatic Continent....Our abundant little spotted flycatcher affords us a good example of a bird with a very extensive distribution."



B.—SAND-MARTIN.

(Photos by the Author.)

"The breeding-distribution....occupies an immense area of the Globe. During our winter-season the energetic little traveller sojourns in the Tropics of Asia, Africa, Central, and South America."

strongly represented. Some of our British birds have such a remarkably wide geographical distribution that they penetrate far eastward into the Asiatic Continent, travelling to high latitudes in Siberia in the summer to breed, and migrating to India for our winter-season.

EXTENSIVE BREEDING DISTRIBUTION OF SPOTTED FLYCATCHER.
AND SAND-MARTIN.

Our abundant little spotted flycatcher affords us a good example of a bird with a very extensive distribution. Some well-known little birds can beat even the spotted flycatcher in the extent of their geographical distribution. We are familiar with the sand-martin, which breeds in colonies in holes which it excavates in sand-banks (a favourite resort being sea-cliffs of no great height), composed of loose soil. On the wing this dainty creature is exactly like a miniature swallow, twisting and turning with extraordinary adroitness and velocity. Well, the sand-martin in seeking out its breeding-haunts when migrating northwards in spring, spreads itself far and wide not only over the European but also the Asiatic Continent as far as Kamchatka, the extreme eastern limit; nor does its distribution come to an end here, for this species may be found breeding in Alaska, and in the district of the Mackenzie River. Thence it can be followed across the Continent of the New World to Newfoundland. In other words it spreads itself *right across Canada*. Furthermore, while its breeding-range extends to about 70°N.Lat. (that is to say well within the Arctic Circle), and in Europe to the northern limits of Scandinavia and the Continent generally, it nevertheless breeds in Europe as far south as the Mediterranean Sea, and sparingly actually in North Africa, while eastwards, in corresponding latitudes, it extends its breeding-range to

The Geographical Distribution of the Sand-martin.

EXPLANATORY KEY TO FIG. 54. (MAP).

The breeding-haunts are encompassed by *dotted lines*; the southern haunts by *broken lines*.

The *arrows* indicate the direction of the fly-lines. Arrows passing in opposite directions indicate that fly-lines, starting from different areas, converge and overlap.

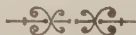
It will be seen that the breeding-range is remarkably extensive in longitude. The fly-lines of migrants setting out from their southern quarters in the Old World, may be traced from the Atlantic-facing sea-board of Europe across the Continents of the Old and New Worlds. The North Atlantic Ocean offers a barrier; hence the migrations—which nearly encircle the Globe—are accomplished by an immense Trans-Continental route to Kamchatka, across Bering Strait to Alaska; thence by another lengthy Trans-Continental route across Canada.

Birds which set out from their southern quarters in the New World, steer in the opposite direction when extending their travels longitudinally. Their fly-lines converge, meet, and in some cases overlap to a considerable extent those of migrants pursuing the Old World route. The regions at which overlapping occurs, are indicated on the map by arrows, which, in passing one another, point in opposite directions.

In latitude, the breeding-range is also remarkably wide, the *dotted line* reaching within the Arctic Circle (70° N.), and intersecting North Africa, Egypt, and Palestine (30° N.)

On the other hand, the areas enclosed by *broken lines* shew that the bird sojourns during our winter-season within the confines of the Tropical Zone. Yet, within these restricted latitudes, (20° N. to 20° S.), the little traveller spreads itself far and wide longitudinally, sojourning in the Tropics of Asia, Africa, Central and South America.

On consulting the map, it becomes evident that in longitude, the *geographical distribution* includes an enormous area of the Globe. Doubtless, some of the migrants which reach regions remote from the British Isles are represented by Oriental and New World forms: nevertheless, Sand-Martins, identical with those occurring in our Isles, and on the Continent of Europe, have been recorded from the Far East and America.



Egypt and Palestine. It is evident that not only in latitude but also in longitude the breeding-distribution of this species occupies an immense area of the Globe. During our winter-season the energetic little traveller sojourns in the Tropics of Asia, Africa, Central, and South America. (PL. XIX. Fig. 54.)

GREAT VARIATIONS IN EXTENT OF TRAVELS.

An extremely interesting fact may now occur to your minds, namely, that some sand-martins, in seeking out their breeding-haunts, take *very much shorter* journeys than others. We have already learned that *some breed in Northern Africa* and in the countries fringing the Mediterranean Sea! To reach these areas would mean hardly half a day's journey. Contrast this with a journey from Equatorial Africa to the North Cape, which would take several days to accomplish.

From the foregoing account it is manifest that the breeding-distribution of this species both in latitude and longitude is remarkably extensive. On the other hand its southern distribution is *very extensive in longitude but restricted in latitude*, because the bird sojourns during our winter months *strictly within the confines of the Tropical Zone*. The sand-martin is one selected out of many which spread themselves widely over the Globe for breeding-purposes. (Fig. 54.) Its congeners, the house-martin and swallow, have also a very extensive breeding geographical distribution.

RESTRICTED DISTRIBUTION OF NIGHTINGALE.

Some species, however, are remarkable for their more restricted distribution. The nightingale, for instance, is rare in Great Britain to the west of Devonshire, while the evidence that it has ever been found in Ireland is quite unsatisfactory. Furthermore, while this grand songster is

generally distributed throughout Central Europe, its northern travels do not take it beyond Germany. Here, then, is a bird whose European distribution is much restricted both in *latitude and longitude*.

The subject dealing with the distribution of our summer-birds in their breeding-haunts is one which, if particulars were given of all well-known species, would afford ample material for a separate book. Here it has been sufficient to indicate a few species to typify cases of restricted and extensive range. The whole study of the distribution of birds, past and present, over the face of the Globe, is entrancing—surprise after surprise awaiting us at every turn. I can only make a passing reference to the subject again when dealing with other phases of migration.

WARM WELCOME AWAITS OUR SUMMER-BIRDS.

In the meantime it is delightful to think that the advent of the insectivorous birds above indicated, which visit our Isles and elsewhere in spring, arouses in everybody a very keen interest. The reason is not far to seek. Are not these birds the glad heralds of joyous events; messengers of a glad season, telling us to bid farewell to the drear days of winter, and to accept their welcomed advent as symbolic of sunshine, foliage, blossom, and music? Yes, indeed, music! for have we not in their ranks our beautiful and dainty little *warblers*, sweetest minstrels of the feathered world, some of the most famous vocalists, such as the nightingale, the blackcap, the garden-warbler, the willow-warbler, and many others, which by their melodies impart a sense of rich, lasting joyousness. Coupled with their sweetest lays, are not our warblers the most elegant and dainty of all the feathered tribe, and if plumage cannot lay first claim to beauty—though it actually

can in some species—naught can excel their beauty of deportment and form ?

Furthermore, the vernal migrations have for their mission the supreme purport of life. Irresistibly the travellers are borne 'on wings of love' to their nesting-sites ; irresistibly the goal is reached with feverish haste. Mating speedily



FIG. 55.—BLACKCAP AND WILLOW-WARBLER.

"Beautiful and dainty....sweetest minstrels of the feathered world."

follows, then nest-building, egg-laying, patient brooding, and tender care of the offspring, all the fulfilment of passionate desires and cherished aspirations. Can it be gainsaid that to watch the birds in the zenith of their enjoyment fills our hearts with joy ? Have we not oft been entertained, nay more, highly amused at, and instructed by, the elegant, subtle, and æsthetic manner in which love-antics, dances, and display of plumage and other decorations, are accomplished by the male in the presence of the prospective partner to

whom he 'offers his hand'? Have we not thoroughly enjoyed those vocal love-lyrics, so dominant in courtship and the earlier stages of wedded life? Have we not watched with keen interest the building of the nests and the feeding of the young? Are not our hearts gladdened when we



FIG. 56.—SWALLOW FEEDING CHICKS.

"In what an amazingly short time another chick receives its moiety!"

behold a swallow poise for an instant on fluttering pinions, and allow the captured flies in her mouth to be transferred to her offspring, whom, with several brothers, sisters, and cousins, we see perched in line on a telegraph-wire? What a speedy performance on the part of the parent, and in what an amazingly short time another chick receives its moiety! Away and back again, and another youngster is fed, and so on until each one of the brood has in turn received its share. (Fig. 56.)

Surely it would be indeed difficult not to realise that these charming summer-birds carry the message that they have come to their *true home*, so instinctively dear to their hearts; the home where all the activities of domestic life are carried out with that zeal which never for an instant flags, activities which occupy practically the whole time that the



FIG. 57.—CUCKOO SINGING.

Observe that the mouth is closed and the throat inflated.

"Who...is not glad to stop and hearken to...the mellow, two-syllabled flute-tootle of the cuckoo, even if these strains, through repetition, tend to grow at last monotonous?"

migrants sojourn in our Isles; for let it be remembered that two, or in some cases three, broods are reared. Hence we see why our *summer-birds* are so well-known and greatly beloved.

WELCOMED UTTERANCES.

Again, sturdier birds of coarser fibre, likewise proclaim their arrivals by welcomed vocal utterances. Who, in the twilight of a fine evening in May or June, is not glad to stop and hearken to the raucous, rasping, notes of the corn-crake, which seem almost to start the growing grass-stems of the meadow vibrating; or to the mellow, two-syllabled flute-tootle of the cuckoo, even if these strains, through repetition, tend to grow at last monotonous? (Fig. 57.)

Yes; everywhere and at all times, before sunrise and after sundown in spring and early summer, the sweet melodies of our little minstrels are wafted to our ears!

In truth, even to the most untutored persons, in so far as bird-studies are concerned, the pronouncedly characteristic form and flight of the swift, the swallow, and the martin, and the unmistakable bird-language of the cuckoo and the corn-crake, are very well-known and never fail to arrest attention.

So, now be sure to look out for the summer-birds; study their charming, winsome, ways in their natural haunts, my young friends, and you can rest assured that the pleasure derived will more than carry its own reward. In the succeeding chapter we shall have some points of interest to learn about our *winter-visitors*.

CHAPTER XXI.

OUR WINTER LAND-BIRDS.

WHY THEY ARRIVE UNNOTICED AND, IN A LARGE MEASURE, ESCAPE DETECTION.

Winter-Migrants—Arrival of huge hosts in autumn—Wide-spread wave of migration over the European Continent—Period of departure of summer-residents overlapped—Advent of winter-migrants uneventful to ordinary folk—Reasons—Vast numbers represented by our own residents—Augmentations misinterpreted—Flocking—Marked paucity of additional species of land-birds—Vocal utterances subdued—Song hushed to sleep—No marked peculiarities in deportment, flight, or plumage—Additional species inhabit outlying districts—Short, dark, and drear days in winter handicap observations in the field—Opportunities for studying habits of summer and winter-birds very different—Bird-life observed in our gardens in winter and summer—Winter-visitors largely represented by augmentation of our own breeding-species—We see only the same birds which are with us all the year round—Summer-birds form a new fauna; charming, peculiar, and characteristic—Hard, frosty weather befriends the ornithologist—New winter-visitors, not representatives of our breeding-species, appear on our lawns and in our gardens—A north-east blizzard sends a mysterious stranger to our door—Description—His name?—Whence has he come?—A most interesting investigation—How to solve the problem.

IN taking leave of the engrossing story concerning the movements, distribution, and habits, of our *summer-residents*, recounted in the previous chapter, we ask ourselves a very interesting question.—When swallows, swifts, warblers, cuckoos, and corn-crakes, flit away in autumn to spend our winter months in Afric's sunny climes (many species also

dispersing themselves far and wide over other lands of sunshine), have the migratory movements of birds in relation to the British Isles and elsewhere, come to a standstill until the ensuing spring? No; far from this being the case, numbers of other migrants pour into our Isles in autumn, appearing at the same time over vast areas of the European Continent. In many cases their arrival overlaps the period of departure of our summer-residents.

UNEVENTFUL ADVENT OF WINTER-BIRDS.

Speaking generally, these birds come prepared to spend the winter. Nevertheless, while they arrive in very great numbers, *their advent to ordinary folk is uneventful*, for reasons very easily explained. In the first place, a great many of the species are represented by those which have been already with us, such as chaffinches, robins, blackbirds, thrushes, larks, and starlings. It is obvious that only the expert observer would be attracted by the augmentation in numbers. Indeed any observer not well versed in the subject of bird-migration, might readily come to the conclusion that the appearance of great numbers of these species in a district, merely signified flocking, especially as there is a tendency for such birds to gather together into parties and grow more sociable after the nesting-season is over.

In the next place, there is a marked paucity of *additional species of land-birds*, although great numbers of each species may pour into certain areas.

SONG HUSHED TO SLEEP.

Thirdly, these additional species arrive at a time when vocal utterances are, in a great measure, subdued; indeed when song is hushed to sleep.

Fourthly, there is nothing distinctive in their form, deportment, flight, or plumage, to arrest attention. Perhaps it may be well to regard the snow-bunting as an exception, for when it spreads its wings the extensive white patch at once attracts notice. However, this charming bird, considering the numbers which visit our Isles, is not generally well-known.

Fifthly, except when the rigors of frost and snow become intense, the additional visitors keep to outlying districts; in some cases they frequent distinctly inhospitable regions.

If, in conjunction with these facts, we take into consideration the short and often drear days of winter, it is not difficult to understand why, during an ordinary country-ramble, the observer might readily overlook these visitors. Indeed the opportunities for studying the habits of summer and winter-migrants are quite different. Many summer-migrants are around us everywhere.

BIRD-LIFE IN OUR GARDEN IN SUMMER AND WINTER.

For instance, supposing it be our lot to live in a suburb within a stone's throw of the city, and supposing we possess but a small garden, yet on opening our door on a bright morning in the month of May it is quite likely that we may see a swallow or two '*hawking*' for gnats; higher up, swifts indulge in amazing wing-movements; the chanting of a willow-warbler (perhaps more than one), may fall pleasantly on our ears; and if fortune particularly favour us, the superb '*water-bubble*' carolling of a garden-warbler may pour forth from out the shrubbery. (Fig. 52.)

Bird-life observed in the garden in winter is very different. The summer-birds having gone, no new species seem to be present. We see the same birds which are with us all the year round. A few species among this lot do not migrate, at

all events to any appreciable extent, for instance, tits and sparrows. However, some of the blackbirds, thrushes, starlings, robins, and chaffinches, may be visitors from Scandinavia and other parts of the Continent. Nevertheless, they also represent breeding-species, which are with us all the year round. If however the weather should become severe, we might be favoured with the presence of one or two visitors, other than northern representatives of our own breeding-species.

A NORTH-EAST BLIZZARD.

“Let’s pretend” that it is mid-winter and that three days ago a fierce north-east blizzard set in; the wind howled dismally, and snow fell heavily without intermission for fifteen hours, covering up the victuals which otherwise bounteous Nature would have provided. Even holly-berries, which the thrushes and blackbirds readily devour (especially in hard weather), were swept to the ground, and buried beyond reach in the snow. Down fell the thermometer some degrees below freezing-point, and for four days and nights *Jack Frost* held sway, gripping the weather as tightly as though he held it in a vice. (Fig. 53.)

Severe arctic conditions now set in and prevailed.

When the blizzard had abated somewhat, we started to provide plenty of food for the birds. The surplus table-fare from breakfast, dinner, and tea, greatly *tickled the palate* of our hungry feathered companions. In addition, we thought it better to purchase a bag of seeds and grain as a special treat for the finches, and for that kind act we found ourselves well rewarded. For, when peeping out of the window, on the third day of this severe arctic weather, we discern amidst a goodly number of familiar garden-birds, a charming species,—

A MYSTERIOUS STRANGER AT OUR DOOR.

quite a new-comer. We note that in size, shape, and deportment, it closely resembles a chaffinch; with a small party of the latter we see it feeding on the grain which we have strewn plentifully for the past two days on a well dug-up portion of the ground. Looking closely, we observe that a deep fawn-colour (almost warming into a reddish-buff shade), pervades the wings, throat, and breast, and that the head and back are mottled brownish-black. Furthermore, a very conspicuous *black bar* crosses the wing, offering a striking contrast to the conspicuous white bar which forms a corresponding mark in the plumage of the chaffinch. What is the name of this strange visitor, and whence has it come? (PL. XX. Fig. 66.)

Before finding out these and several other particulars which are given in the next chapter, pay a visit to the museum and try, without reading the label on the stand, if you can identify the bird from the short but accurate description of its dress which I have given. Failing a visit to the museum, take a look at a coloured plate in one of the many popular books on birds. No doubt the school-library will come to your aid.

“Let’s pretend” that the weather will continue unusually wintry for some days to come. We are delighted, because then ‘Jack Frost’ has promised to send another strange and most welcome visitor to our door-step. The exciting story of these visitors will be narrated in the next chapter.

LECTURE 14.

CHAPTER XXII.

JACK FROST SENDS ANOTHER VISITOR.

A BRAMBLE-FINCH AND A REDWING JOIN THE WINTER GARDEN-PARTY.

Bramble-finch closely related to chaffinch—Resemblance in form and size—Difference in plumage—Widely-distributed winter-visitor over Europe and Asia—Home, Sub-Arctic Europe and Asia—Habits and food—Frequents uncultivated lands—In hard weather, farmsteads and gardens—We feed our visitor and prolong its stay—Thrush appears near our door-step on a very frosty morning—Small size, orange-red flanks, and white stripe over eye—Redwing—Delighted to identify in good light and near at hand—Thanks to you, 'Jack Frost'—Song—thrush comes alongside his northern cousin—We view their breasts—Clearly note the difference in pattern — Redwing, a winter-visitor from Iceland, Sub-Arctic Europe, and Western Asia—Reaches our Isles—Also travels further south, even to North-West Africa, India and Persia—Cause of winter-journeys of both birds—Lack of food and want of day-light—Some redwings breed as far south as Central Europe—Migrate east to west in hard weather—Keep to open country except in frosty weather—Gardens then visited—Fieldfare, another abundant migrant, though not well-known—Distinguishing characters—Gregarious—Larger than starling, and longer tail—Very rarely seen in gardens—Migrations and distribution somewhat similar to those of redwing—Waxwing occurs some winters in large numbers—A conspicuous bird which arrests attention—Great grey shrike—Lapland bunting—Crossbill—Snow-bunting—Mealy redpoll—Habits—Distribution—Plumage—Personal experiences—Anecdotes—An interesting old farmstead by the coast—The remaining small regular winter land-migrants, mostly inconspicuous and largely overlooked—All small birds should be most carefully scrutinised with binoculars in the winter—Absence of song, inconspicuous markings, and dark weather, handicap our chances of identification—Winter small birds should be most diligently studied in the field.

WELL now ; my young friends, have you discovered the name of the bird which I described at the end of the previous chapter ? If you have not solved the problem by this time, I really must furnish the answer straight away. You never could guess : the bird so rarely visits our town-gardens that its appearance is not familiar. Before I divulge the name, please take one more glance. Now is your chance : the bird, " let's pretend," is hopping about at the doorway. How remarkably like a chaffinch, in size, shape, deportment, and movements. Observe the quiet yet pretty and sprightly manner in which it bounces along the patch of ground from which the snow has been cleared. In length and shape could the beaks of the two birds be more alike ? True, the plumage differs to a considerable extent. In these closely related finches, we therefore find one interesting distinction.

A BRAMBLE-FINCH AT OUR DOOR-STEP.

Our heartily welcome guest is a *Bramble-Finch*, also known as *Brambling*, a winter-visitor, not only to the British Isles, but also to vast areas of Europe and Asia. This species is therefore widely distributed in both latitude and longitude in winter.

Where has it come from, and for what purpose has it arrived in our country ? It has descended from its breeding-haunts—its true home—in the vast pine and birch forests of Sub-Arctic Europe and Asia, its range extending over an immense area which stretches from Norway to Kamchatka ! In such latitudes day-light in winter is too short to permit the bird to procure sufficient food for its daily wants, even if such were available. But it is likely that the supply of food would have become so reduced that migration became obligatory. (Pl. xx. Fig. 66.)

It must be remembered that in winter, in high northern latitudes, tremendous tracts of land become enveloped in snow and ice. It should be noted, however, that the bird, after having had a good time feasting upon the ripening grain, does not wait until food grows too scarce. At the close of the harvest it sets out upon its travels, strong and vigorous in health. On reaching its destination it seeks out the cover of woods and glades where, from October onwards, large or small parties may be observed in our Isles, foraging for beech-masts, a favourite diet. When such food runs out, bramble-finches join company with chaffinches, greenfinches, and other familiar seed-eating birds, some or all of which may likewise have descended from Northern Europe. With these companions they frequent the rough stubble and uncultivated pasture-land, picking up what seeds, suitable to taste, are procurable, small berries included. If the weather begin to shew signs of severity, then bramble-finches approach the farmsteads, gaining more and more confidence when piloted by less shy companions. However it is only through dire necessity for food, as when severe, frosty weather sets in, that one or two will approach our suburban gardens. Therefore, this species differs in its habits from our chaffinch which, in mild no less than severe weather, fraternises with sparrows at our door-steps. Some chaffinches, however, I have noticed are very much wilder than others. Often those which keep to the rougher and more exposed districts are winter-visitants from colder climes.

"Let's pretend" once more, that it is winter and the frost continues. Next morning is colder but sunny overhead. Yesterday we peeped through the window; we dared not open the door for fear of frightening the birds. This morning they are still more numerous and so we must be content to

A Stranger at our Door=Step.



A.—CHAFFINCH.

"Our chaffinch...in mild no less than severe weather, fraternises with sparrows at our door-steps. Some chaffinches, however,....are very much wilder than others. Often those which keep to the rougher and more exposed districts are winter-visitors from colder climes."



B.—BRAMBLE-FINCH.

(Photos by the Author.)

"A very conspicuous black bar crosses the wing, offering a striking contrast to the conspicuous white bar which forms a corresponding mark in the plumage of the chaffinch. ...How remarkably like a chaffinch, in size, shape, deportment, and movements."

utilise the same observatory. We are delighted to see our brambling again, feasting away contentedly on the grain.

At the moment, however, our attention is riveted upon a thrush among a company of seven others and three blackbirds.

‘ JACK FROST ’ SENDS ANOTHER VISITOR.

We see at a glance that the bird is smaller than its companions, and the brown colouration of its upper plumage is darker and colder in tone. Now the stranger is advancing towards the window, and a bright beam of sunshine lights up its plumage; therefore seize this golden opportunity and observe as quickly and accurately as possible its distinctive markings. We cannot fail to notice two *broad white streaks*, one over either eye. They are certainly conspicuous markings, extending forwards to the root of the beak, and backwards to the nape of the neck. We also observe the rich orange-red feathers which flank the lower border of either wing. If the wings were raised we would see a much more extensive patch of these peculiarly ruddy-toned feathers.

What, then, is the name of this interesting bird?

A *Redwing*, well named on account of the warm, rufous-shaded feathers which line the wings and spread to the flanks. We recognise that its seven companions are all song-thrushes, without white eye-stripe, without red flanks. Look once more—we are in luck! The new-comer and one of the song-thrushes now stand directly facing us, affording a splendid view of their breasts. We discern a decided difference in the respective plumages. *The breast of the song-thrush is spotted, that of the redwing streaked or finely striped.* The ground-colour in each is dull-white, with some tawny shading on the breast of the former. (PL. XXI. Fig. 66.)

I feel sure you have all made up your minds that our visitor is a typical *thrush* in pattern of plumage, deportment, and other features. Look at the deliberate manner in which it bounces hither and thither from one little patch of ground to the other. See how it turns its head, and casts a contemplative gaze on some expectant worm ! Just tap the window : observe, the bird has promptly become suspicious of danger, and stretching its neck has dropped its wings below its tail, and has started to flick them with rapid beats against its flanks.

Yes, Mr. Redwing, you have proved yourself to be a genuine thrush, and if we observed you on the wing, we would add to this testimony ; but we shall disturb you no more. You are our much welcomed guest from overseas. Stay with us in our little garden and partake cordially of what hospitality we can offer.

MIGRATORY MOVEMENTS OF THE REDWING.

Whence came this stylish traveller ? He has undertaken a journey all the way from Iceland, or Scandinavia, perhaps still further off, say, from Northern Russia or even from Asia as far as the Yenesei river ; or he may have flown from North-East Prussia and the adjacent area of Eastern Russia in a *bee-line from east to west* ; though it is much more likely that the journey was made from latitudes high up in Northern Europe or Asia, the more typical breeding-home.

The redwing is a winter-visitor, but *mark*, not only to our Isles, but away down to Southern Europe and Northern Africa ; eastwards to Persia and North-West India.

Why did it leave its home ? Primarily in search of adequate feeding-grounds, and if the traveller happened to be one which descended from high northern regions, the want

'Jack Frost' sends another welcome Visitor.



A.—SONG-THRUSH.

"Look...we are in luck! The new comer and one of the song thrushes now stand directly facing us. We discern a decided difference in the respective plumages. The breast of the song thrush is spotted, that of the redwing streaked."



B.—REDWING.

"We cannot fail to notice two broad white streaks, one over either eye. They are certainly conspicuous markings...We also observe the rich orange-red feathers which flank the lower border of either wing."

of day-light in winter would prove an additional migratory factor. If, however, *an east to west flight in our latitudes were undertaken*, then the colder weather of the Continent drove the bird to seek out the milder climate which we in the British Isles enjoy.

Like the Bramble-finch, the Redwing is a native of northern regions. Here, it is found in greatest abundance, but unlike the Bramble-finch, its home also extends southwards as far as our latitudes, but not as far westward, i.e., our longitude. We find this thrush is a *native* in parts of Prussia, where, in other words, it breeds. From that country it would, under ordinary circumstances, migrate southward in winter to countries fringing the Mediterranean, rather than westward. To the British Isles (which are situated in much the same range of latitude as Prussia), we have found that the Redwing is only a winter-visitor.

On reaching its winter-quarters the bird resorts as a rule to the open country where, from October onwards, it may be seen consorting with other species of thrushes. It is a sociable bird, and often gathers into flocks of considerable numbers. Despite this fact, it is not well-known to the person interested in birds in a moderate way.

As long as the winter weather remains mild and open, the Redwing finds food enough in stubble and uncultivated pasture-land, and, where berries are plentiful, small parties may be seen along the hedgerows, pecking very vigorously and gulping down voraciously these favourite tit-bits.

Cultivated lawns and gardens in suburban districts are very seldom visited until the weather becomes severe. Then, however, the bird pays us his much welcomed visit. (PL. XXI.)

Having now pointed out that the *land-species* which come to our Isles as winter-visitors (quite exclusive of those

which arrive in winter but are also known to breed with us), are few in number, I shall make just a brief reference to these birds. First of all there is really only one other, in addition to those already mentioned, which is common enough for you to come across in an ordinary ramble in the open country-side. I refer to the *Fieldfare*, another member of the *thrush-family*.

THE FIELDFARE AND ITS DISTINGUISHING CHARACTERS.

The beginner might easily overlook this bird were it not for the fact that it is distinctly gregarious, and fieldfares in a flock can readily be distinguished from starlings in a flock by their superior size and much longer tails. The fieldfare is distinctly larger than the redwing, and also than our own song-thrush, and from our familiar, beautifully and profusely spotted *Missel-thrush* it may be distinguished (if sufficiently close and well lighted up by the sunshine), by its slate-grey neck and rump, its warm chestnut-brown back and wings, and its almost *black tail*, which is proportionately longer. Unlike the missel-thrush, its breast is sparsely streaked rather than profusely and boldly spotted. Lastly, the fieldfare dips less in its flight than the missel-thrush. (PL. XXII.)

Again, the fieldfare is wilder and more wary than the redwing, and being more hardy, it is seldom dislodged by severe weather from the rough pasturage and stubble of the open country. Its visits to suburban gardens are quite exceptional. Its migrations and distribution follow in the main those of the redwing.

To complete our list we have to mention only the *Snow-Bunting*, the *Warwing*, the *Great Grey Shrike*, the *Lapland Bunting*, the *Crossbill*, and the *Mealy Redpoll*. With the exception of the snow-bunting none of these species abound in our Isles regularly every winter. There is considerable

Hardy, Betty, Thrushes.



A.—MISSEL THRUSH

"Our familiar, beautifully and profusely spotted missel-thrush....with undaunted courage....at the approach of a hawk....would....immediately launch an attack."



B.—FIELDFARE.

(Photos by the Author)

"The fieldfare....may be distinguished by its slate-grey neck and rump, its warm cheslnut-brown back and wings, and its almost black tail....it is seldom dislodged by severe weather from the....open country."

fluctuation in numbers from season to season. The wax-wing, the crossbill, and the mealy redpoll, have appeared in unusually large numbers quite unexpectedly during certain seasons, but these species cannot be looked upon as plentiful British winter-migrants in the technical sense of the word. Indeed the waxwing and the crossbill (and the mealy redpoll in a lesser degree), come much more prominently under the category of *irregular* though *expectant migrants*, which in some years, but not in others, *invade* our Isles in surprisingly large numbers. We shall have some more to say about the interesting migrations of the waxwing and crossbill in a subsequent chapter, when the classification of irregular migrants receives treatment.

Here, however, let me point out that the two birds are remarkable in dress, form, and deportment, and being singularly tame, can be easily identified at close quarters. The *invasions* therefore of these birds from time to time have been chronicled synchronously from several districts as highly interesting and exciting events.

MIGRATIONS OF THE GREAT GREY SHRIKE AND LAPLAND BUNTING.

The great grey shrike, intermediate in size between a sparrow and a song-thrush, is on the whole a fairly regular annual visitor, but it is by no means plentiful in any season. Moreover its annual visits affect the east coast of Great Britain. On the opposite sea-board it is irregular and somewhat rare, while in the Hebrides, Wales, and Ireland it becomes a very rare *casual visitor*. (Fig. 58.) Therefore, while it is true that the pearl-grey upper parts, black cheek-patch (ear-coverts), black wings and tail, with white edgings to some of the feathers, and white under parts, render the dress conspicuous ;

nevertheless the great grey shrike is liable to be overlooked, owing to paucity in numbers and its wary and solitary habits. The male Lapland bunting is also a rather gay bird, especially in its nuptial plumage, when the head, cheeks, and throat-gorget, are jet-black, strongly contrasting with the broad white



FIG. 58.—GREAT GREY SHRIKE.

"A fairly regular annual visitor, but it is by no means plentiful in any season."

stripe over the eye, and its continuation down the side of the neck. The tawny-coloured upper parts behind the head also contrast with the whitish under parts, the flank-feathers of which are broadly and boldly streaked with black. In the winter-plumage—the costume in which the bird appears most often in our Isles—much of the contrast markings,

however, are obscured by the presence of long buff or brownish-shaded tips to the feathers, and a buffish-tinge pervades the white under parts. In the female the markings are less conspicuous, and the head, in the nuptial plumage, though growing darker, never becomes uniform jet-black. On the whole it may be said that the plumage of this bird in winter



FIG. 59.—LAPLAND BUNTING.

"Bear in mind that the breeding-haunts....are almost circumpolar."

is not sufficiently conspicuous to arrest attention, and the general opinion—with which I see good reasons for agreeing—is that the Lapland bunting is overlooked to a large extent every year. However, in studying its migrations, we must bear this in mind, that it is distributed mainly along the east coast; elsewhere it becomes a rare and casual migrant to the British Isles. (Fig. 59.)

FLEETING VISIT OF LAPLAND BUNTING.

Furthermore, the Lapland bunting hardly ever remains throughout the winter with us, therefore it should be eagerly sought for in September and October, when it touches our coastlands most frequently on its journeys southwards from far away northern climes. Its occurrence in mid-winter is much rarer, due perhaps in part to its being over-looked. One would expect the Lapland bunting to sojourn with us throughout the winter, seeing that its normal migrations over the European Continent do not extend south of our latitudes. It appears regularly in Heligoland in the autumn. When we bear in mind that the breeding-haunts (where it is an abundant species), are almost circumpolar, we wonder all the more why it has not selected our Isles as a suitable,—we might even think 'fashionable'—winter-resort!

IMMENSELY WIDE WAVE OF MIGRATING SNOW-BUNTINGS.

As a welcome visitor—sometimes as early as September and remaining till April, and even lingering on in lesser numbers until May—the *Snow-Bunting* stands out in contrast to the *Lapland Bunting* in regard to numbers and distribution. For although the former chiefly selects the coast, it is widely distributed over the entire sea-board of Great Britain and Ireland. I have found this sprightly creature abundant all round Ireland, both on the beaches of the mainland and also on the adjoining islands. I have frequently procured it from Irish light-stations and have picked up many dead specimens, which met their fate by striking the lantern. I have also come across the snow-bunting far away from the coast; for instance on Sheffield moor-lands. Inland, however, it is much less common. The breeding-resorts are very widely distributed round the Arctic Circle.

In autumn an immensely wide migratory wave sweeps down the Continents of Europe, Asia, and America. The European sector is continued south of our latitudes, but the numbers of migrants thin out very considerably before the countries bordering the Mediterranean are reached ; nevertheless, this indefatigable traveller presses forwards as far as North Africa.

While many sojourn in the British Isles for the winter, there are immense numbers of *passage-migrants* which merely touch upon our shores when journeying south. Such movements go on until nearly mid-winter. The *birds-of-passage*, when returning in March and April, also pay us a short visit, and in many instances they join up with the outgoing winter-visitors, the birds, in a vast concourse, wending their way homewards to breed around the Polar basin.

I have noticed in spring, quite an augmentation of snow-buntings on bleak, remote islands, off the coasts of Ireland. No doubt the birds here were largely represented by *passage-migrants*. Now, as the snow-bunting is not only a beautiful little creature but is also an abundant winter-visitor, let us jot down a few field-notes which will serve a useful purpose when we come across the bird, as we are almost bound to do, if occasions are afforded of visiting the coastlands in winter.

We noticed that its migratory movements are far and wide. This is not to be unexpected, for, belonging to a race peculiar to itself, it is to be observed that the wings are much longer than in the typical buntings. The male snow-bunting is a very noticeable little fellow, displaying an amount of white in his dress which is not to be found in any other of our common small British birds. Moreover as he rises from the ground, he delights, in the ecstasy of his flight, in whirling his wings about in the wildest and most erratic manner.

A BEAUTIFUL 'BUTTERFLY' BIRD.

As a result *we are forcibly reminded for the moment of a huge butterfly fluttering along.* It is at this moment of rising that we are struck by the large amount of white in the wings and tail.

'Once seen, never forgotten,' is a saying which I think may safely be applied to the snow-bunting when he first spreads his wings to fly clear of danger.

However, as a matter of fact, our little friend is not particularly shy, and in good light he can be quite easily identified without the aid of a binocular. It is not necessary to sneak or crouch; he may be quietly approached within close range on the open. But now the question arises: have you observed the snow-bunting in the neighbourhood of Sheffield in winter? Not many of you have, I should venture to remark. Yet thousands of these delightful birds pour into the British Isles every autumn and remain for the winter.

But, as we have seen, they are coast-loving; it is only the few, for the most part stragglers, which drop out of the ranks on migration (very likely carried inland by fog or storm) which we come across in Sheffield. Here in early winter (November is the most usual month), stray individuals from time to time may cross our path. I have several Sheffield records, mostly of these solitary vagrants, and nearly all from wild, moorland haunts.

On rare occasions I have observed a few mustering together, to form a little party. On the coast, snow-buntings collect into flocks, and then the flicker of 'snow' from scores of fluttering pinions is a very pretty and an arresting spectacle: while the wild, yet pleasing tinkling chirp, imparts an added charm to the scene. (PL. XXIII.)

A Beautiful 'Butterfly' Bird.



A.—SNOW-BUNTING, ADULT MALE (NUPTIAL DRESS).

"The breeding or nuptial plumage....is very charming. The entire head and back of the neck are pure white; the back and shoulders, black; the rump, white; the tail and wing-feathers, black and white; and all the under parts, pure white. Certainly a lovely study in 'black and white'!"



B.—SNOW-BUNTING, ADULT MALE (WINTER-DRESS).

"In the winter-plumage....the purity of the white under parts is interrupted by tawny markings, especially about the upper breast (where a narrow band or half-circle is present) and the flanks. Likewise, the head and back of neck, the back and shoulders, shew tawny markings."

(Photos by the Author.)

THE CAPTIVE 'FALLS INTO FLESH.'

I am reminded of a weird fact about buntings as a race : namely, that if kept in captivity, and allowed only just an ordinary ration of food, they tend to grow enormously fat ; in this state they soon die. I proved this in the case of a snow-bunting which, just in the nick of time, I rescued from the clutches of a merlin. The little fugitive sought a haven by entering a cottage on a wild, lonely, island. The bird seemed so scared and exhausted, that at first I had grave doubts as to its recovery ; luckily it survived and became so tame—in fact it turned out quite a pet—that I took it home and kept it for three years. It appeared very healthy and happy and used to sing very sweetly, but alas ! one morning it had a fit, and, turning over on its side, died very quickly. When I first procured my bunting it weighed one ounce and a few drams : when it died it turned the scale at three ounces ! In other words it trebled its weight ; or to put the estimation in another way, it put on 200 per cent. weight in captivity !

SAD FATE AWAITS THE CAPTIVE ORTOLAN.

There is a species of bunting called the *Ortolan*, common in many adjacent parts of the European Continent, but only a *rare wanderer on migration to our Isles*. Its natural food consists largely of insects as well as seeds, but in captivity it feeds heartily upon grain and millet, and becomes enormously fat. Formerly, fat ortolans were much in request for table-use. We are out of sympathy with persons who eat these poor little mites, and still more out of sympathy with those persons who net them wholesale for the markets.

A LOVELY STUDY IN 'BLACK AND WHITE.'

The breeding or nuptial-plumage of the adult male snow-bunting is very charming. The entire head and back of the neck are pure white ; the back and shoulders, black ; the rump, white ; the tail and wing-feathers, black and white ; and all the under parts, pure white. Certainly a lovely study in '*black and white*' ! Occasionally one sees the bird in this costume before it departs for its arctic home, generally among those laggards which remain with us until late April or May. In the winter-plumage—the more usual retained during the bird's entire stay in our Isles—the purity of the white under parts is interrupted by tawny markings, especially about the upper breast (where a narrow band or half-circle is present) and the flanks. Likewise, the head and back of neck, the back and shoulders, shew tawny markings. These tawny markings fringe and conceal the underlying black and white pattern of the nuptial-plumage. Immature birds are still more tawny, and were it not for the conspicuous amount of white in the wings (always noticeable in flight), a casual observer might pass these birds by, or, seeing them on the ground with their wings folded, regard them as sparrows or grey linnets. We seldom discover more than one or at most two snow-buntings in nuptial-plumage even in a large flock.

I remember being deeply impressed when I first beheld this lovely study in '*black and white*.' The bird was running nimbly towards me, and was leading the way for a little party, while I lay concealed behind a large boulder. For a moment I took him for a sanderling—a charming little 'sandpiper' which becomes almost white in winter-dress. However, when the bunting turned broadside on, I saw his jet-black back and pied wings and then recognised him.

The snow-bunting always appears to be a very plump, comfortable-looking bird, and it has short feet. One would hardly think, when watching it standing motionless, that directly it started to move on foot it could go fast. But yes, indeed ; it runs with great rapidity and nimbleness. It is curious to note that it also moves along by a series of bounces, (usually called *hopping*), after the very familiar manner in which sparrows and many other common small birds progress on foot.

There is yet another point to indicate in regard to the snow-bunting, and I may here include the crossbill. I have mentioned that the species of land-birds which come to our Isles as winter-visitors—quite exclusive of species which visit us in winter but are also known to breed with us—are few in number. We have now dealt with them, and you remember their names. Bramble-finch, redwing, fieldfare, snow-bunting, waxwing, great grey-shrike, Lapland bunting, crossbill, and mealy redpoll. Now, as a matter of fact, the crossbill and the snow-bunting also breed in the British Isles ; the former in Great Britain and Ireland, the latter only in Scotland. But apart from the well established Irish breeding crossbills, these two species breed so sparingly, and in the case of the British crossbills — excepting the Scottish bird, now recognised as a distinct species — so irregularly, that their status as British residents recedes into the background when we come to study their wonderful migrations which strike a very dominant note. For that reason I have deemed it advisable to include the crossbill and snow-bunting with those winter-migrants which *do not* rather than those which *do breed* with us.

We have *not* fully accustomed ourselves to regard the snow-bunting as one of our native birds, indeed naturally enough, seeing that it breeds but sparingly, and only in the

northern half of the mainland of Scotland. We regard it, in the main, as a northern species which, (together with the brambling, the redwing and the fieldfare), pours into our Isles in immense numbers during autumn, but which streams away from us to reach its northern home at the approach of summer.

The resident snow-buntings of Scotland form, in truth, but a very minute fraction of the entire snow-bunting population which is distributed in winter over the British Isles. Therefore it seems not only more natural but it is actually more instructive to study the migrations of the snow-bunting in conjunction with those of the purely winter-visitors, rather than with the migrations of our familiar native birds, which happen also to be represented by migrants from Northern Europe, and which come to our Isles for the winter.

AN INTERESTING OLD FARMSTEAD BY THE COAST.

"Let's pretend" that we live close by the sea-coast, a quiet, rural spot, teeming with bird-life, away from town, noise, and human traffic. We take a ramble in December and visit an interesting old farmstead, prettily flanked with charming little woods and copses of larch and silver-birch. Rabbits scuttle through the undergrowth of bracken, magpies chatter in the branches above, curlews and redshanks pipe melodiously in the swamp hard by, and small birds in goodly numbers flit to and fro from farm to field. Chaffinches and greenfinches forage about on the hayricks and manure heaps. Starlings squabble and spar in their rude endeavours to purloin a portion of the pig's daily allowance. Rooks turn up the soil in quest of wireworms and cockchafer-grubs. Blackbirds and song-thrushes haul out the worms from under the grasses. A wagtail or two alights, flicks his long tail



FIG. 60.—AN INTERESTING OLD FARMSTEAD NEAR THE SEA-COAST.

"Prettily flanked with charming little woods and copses of larch and silver-birch. Rabbits scuttle through the undergrowth of bracken, magpies chatter in the branches above, curlews and redshanks pipe melodiously in the swamp hard by, and small birds in goodly numbers flit to and fro from farm to field."

energetically up and down, and then, as though propelled by clockwork, nimbly patters along the top of the old stone-wall. Bird-life is prolific and gladdens the heart of the ornithologist. But unless he be a specialist in the study of migration, and unless problems regarding migratory movements be uppermost in his mind, he associates these birds intimately with the farmstead; they are unquestionably natives of his district; his companions year in and year out. Yes; such a picture would surely arise in our minds when surveying this rich and varied feathered fauna of the farmstead. We are certainly much interested, but as yet not excited nor surprised.

Suddenly, a discreet sign from one of our party, made with the finger so as not to disturb the birds, brings us all together to the hayrick. In a great state of excitement we identify a couple of bramble-finches among the chaffinches, and a party of snow-buntings on a grass-patch immediately outside the yard-gate. Side by side on the very same patch we observe a few redwings consorting with several blackbirds and song-thrushes.

Then, like a flash, our thoughts are directed along another channel, namely that of migration. The presence of the bramble-finches, the snow-buntings, and the redwings, starts us thinking of birds native to Scandinavia, and other areas of Northern Continental Europe; of their southerly journeys to our Isles to spend the winter; and of their return north to their homes at the approach of summer. We contemplate on these birds in terms quite apart from their companions with whom we see them fraternising in search for food. But after all, when we allow our thoughts to probe a little below the surface, and when we make use of the knowledge already stored up, surely we are justified in concluding that *all the birds*, or at least a fair proportion of those we saw round the farmstead were likewise migrants from more northern regions.

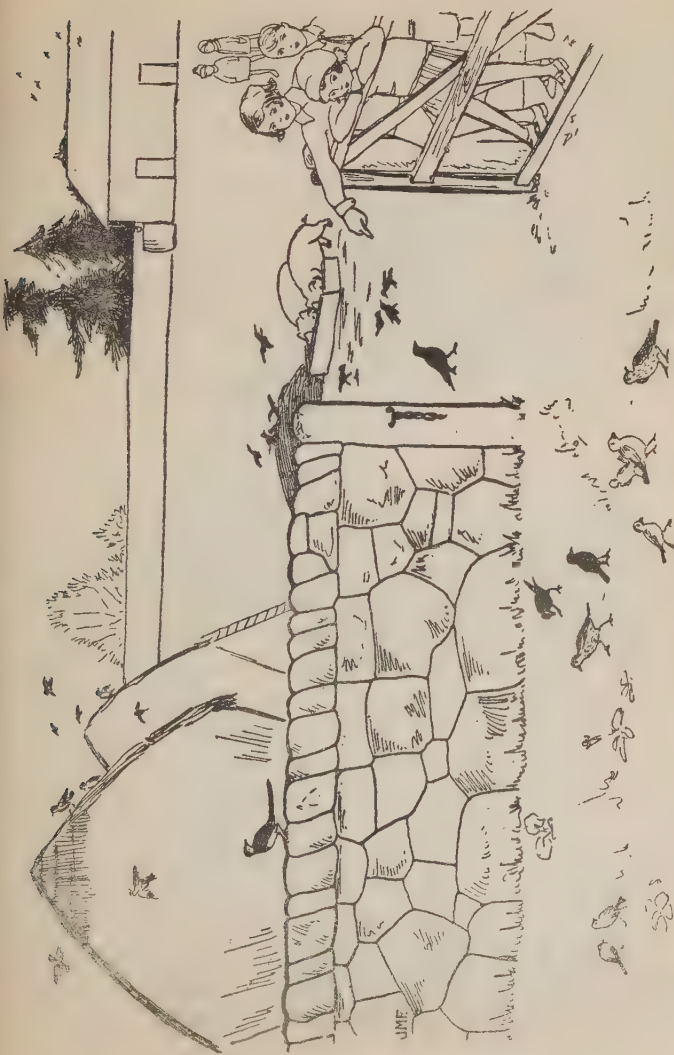


FIG. 61.—AT THE FARMYARD GATE.

"In a great state of excitement we identify a couple of bramble-finches among the chaffinches, and a party of snow-bunnings on a grass-patch immediately outside the yard-gate. Side by side on the very same patch we observe a few redwings consorting with several blackbirds and song-thrushes."

It is precisely because some species, when leaving us in summer, are not represented by individuals which also breed in our Isles and others are, that we are led to draw a chalk-line, and to group together the two kinds of migrants, assigning each to its own proper category.

Here in like manner, though perhaps with somewhat less emphasis, it seems advisable to group the crossbill with the winter-visitors which are not represented by breeding individuals, rather than with those which are so represented.

The moment we call up the crossbill to mind we think of its peculiarly erratic, nomadic, habits, and of its strange, unaccountable *invasions* or *irruptions* into our Isles.

THE FRIENDLY REDPOLL.

Lastly, in regard to the advent of the mealy redpoll, I believe that this bird has been repeatedly overlooked, in as much as it is a quiet, unobtrusive, yet friendly little species, and as sombre-plumed as a grey linnet. Its distribution is mainly to the coast-line of Great Britain including the adjacent islands, where it appears much more as an *irregular rather than as an annual visitor*. Every opportunity should be taken of studying this bird during its occasional *invasions*, because when seen in numbers it is more easily identified. But alas! the *invasions* are as a rule few and far between. It is here unnecessary to describe in detail, the plumage; in common with that of many birds, it belongs to a primitive type, in which the ground-colour is more or less dusky, streaked with lighter and darker shades. The red patch on the top of the head is of course difficult to make out unless the bird be low down, in good light, and very close at hand.

Redpolls, as a class, are most friendly little birds, and do very well in an aviary. We have witnessed the engaging manners of the captive Lesser Redpoll—a familiar native of the British Isles. I have often persuaded this bird to alight on my finger and pick seeds from the hollow of my other hand. I well remember a mealy redpoll, which, having run



FIG. 62.—MEALY REDPOLL.

"Redpolls...are most friendly little birds. I have often persuaded this bird to alight on my finger, and pick seeds from the hollow of my other hand."

the gauntlet across the open for a hundred yards, escaped being snatched by a merlin falcon, through diving down the chimney of the little cottage of an islander. Fortunately for the fugitive the fire had gone out ; so had the inhabitants, save a small boy who, in grabbing at the bird, pulled out its tail ! In this state and covered with soot, the poor little creature looked indeed a sorry spectacle ! I improvised a cage into which I popped the bird together with some seeds.

Next morning the prisoner, with the aid of its beak and the twitching of its skin-muscles, had divested itself of much of the carbon, and a day later the pattern of the plumage shewed up distinctly. The bird grew a beautiful new tail, became very tame, and lived happily for several years.

Its death was uneventful, like that of most cage-birds. I found my little pet lying dead at the bottom of the cage one morning.

DILIGENT STUDY OF WINTER LAND-BIRDS.

Well, now, my young friends, let me summarise. I have already stated emphatically that the coming of the smaller land-birds as winter-visitors to our Isles is an event which, in a large measure, is passed by unnoticed. In the first place because many of them are species which are also with us all the year round, and the increase in numbers, which indeed it would require an expert to notice, is tempered by the exit of similar species from our Isles for more southern latitudes. Secondly, the number of species comprising the purely winter-visitors is markedly small. Thirdly, while it is true that some of these purely winter-visitors have conspicuous plumage, it is also true that with the exception of the snow-bunting, the redwing, and the fieldfare, these purely winter-visitors are by no means common, and in some cases their distribution is local and their visits are irregular.

Therefore let me lay great stress on the point that the markings, build, and movements, of all those small birds which you may happen to come across when taking a ramble in winter, should be most carefully scrutinised. On such an occasion your binoculars will serve a highly useful purpose, especially if glimpses of sunshine favour their illumination. Never neglect to seize the opportunities, when they arise, of diligently studying our small winter land-birds.

Recollect that the dark days of winter, (coupled with the fact that most of the birds under observation are quietly attired and silent of speech and song), seriously handicap your chances of identifying species.

I believe that a ramble by the seaside, with a view of investigating marine bird-life in winter, would prove not only entrancing, but also most exhilarating.

Let us decide without delay to make the expedition, and recount our thrilling experiences in the next chapter.

LECTURE 15.

CHAPTER XXIII.

MARINE BIRD-LIFE IN WINTER.

THE REVELATIONS OF A RAMBLE ON THE SAND-FLATS.

Hosts of aquatic birds—Numerous species—Dominant note of winter-migration—Eventful arrivals—Birds well-known to coast-dwellers—Fowler's special interest—Invocations to the 'Clerk of the Weather'—Observations on the open—Naturalist's weather difficulties—Binoculars necessary—Increase of water-birds on the coast in frosty weather—Frozen lakes and ponds—Severe frost an unpleasant companion for the observer—Cramped, crouched, cold, and wet—Delightful and exhilarating ramble—Mild, sunny, day in December—Visit to an estuary of a large river and its surroundings—Ooze-beds intersected by channels—Tranquil waters—Ducks—Company half a mile long—Various species among the multitudes—Scoters in myriads—Swans in a small party afloat on another channel—Brent geese assembled on a reef of ooze-bed—Dark-plumed birds—A pretty inset in 'black and white'—The whole marine-picture—The estuary itself—Big diving birds—Grebes—Distinguishing characters between 'divers' and diving-ducks—Glaucous Gull appears—Means of identification—Indefatigable wanderer from the Arctic Zone—Breeds right round the North Polar regions—Journeys south in autumn and winter—Widely distributed in latitude and longitude—We scan the sand-flats and ooze-beds—Legions of 'sandpipers' surround us—We observe their nimble and graceful movements on foot—A fascinating study—Numerous species—Variable in size—Upper plumage of most shore-birds resembles the sand—Birds inconspicuous when not flying—Exceptions—Oyster-catcher—Lapwing—Strong contrast colours—Aquatic birds move south in search of longer day-light—Most extensive migrations made by water-birds—Some examples—Turnstone—Curlew—Sandpiper—Greenshank—Glaucous Gull—Immense journeys undertaken by young birds only three months old—Travellers start before, and independent of the parents—No piloting—Marked variation in the range of geographical distribution among individuals of the same species.

WE have learned that winter-migrants, taken as a whole, arrive in our Isles in vast numbers. Furthermore, vast numbers of species, as well as of individuals of given species, pour in. Nevertheless, we have just ascertained that the smaller land-birds among these travellers yield but few additional species: that is to say, species other than those which also breed in our country. Therefore the bulk of our winter-visitors (in so far as additional species are concerned) is comprised of aquatic birds. They far outnumber the land-birds, not only as extra species, but individually. In suitable localities they literally swarm on our seas, estuaries, beaches, and ooze-beds. It is therefore appropriate to say that they sound the dominant note of winter migratory movements. But we may enquire are aquatic birds well-known, and is their arrival a matter of great moment to students of bird-life? Both queries may be answered emphatically in the affirmative. Alas! I fear, however, that there are some among our youthful ornithologists who have been afforded lamentably few opportunities of visiting the coast-line of the mainland and adjacent islands. Happily, the young Britisher, who perforce may dwell inland, is not land-locked to that endless extent which befalls the observer residing in the centre of an immense Continent. Yes; happily many zealous young naturalists among us have surely looked with intense enjoyment and admiration upon the exquisite picture of marine bird-life in winter, a picture painted by the Supreme Artist, Nature herself, on her own canvas.

THE FOWLER'S DREAM.

To the coast-dweller, and more particularly to the hardy and enthusiastic fowler, no birds are better known; truly

indeed their arrival marks an event of astonishing interest ! The fowler, thinking out his plan of campaign when in search of his quarry, will at times invoke the 'Clerk of the Weather' to favour him, now with a north-east gale and a snow-blizzard ; now with dry, hard, continued frost ; now with more genial atmosphere and rise of temperature, and indeed, with many other vagaries of the weather, according to the position of his happy hunting-grounds, and other technical matters, all of which he carefully considers when thinking of his game-bag.

WEATHER AND THE NATURALIST'S MISSION.

To the naturalist, on the other hand—whose mission is to watch patiently rather than to take life—wet, cold, boisterous, weather, especially when gloomy, is a hindrance rather than a help. The reason becomes quite clear when we bear in mind that observations on marine-birds are made usually where little or no cover is available. Moreover, many species of sea-birds are shy and wary, and must be viewed from a distance with the aid of strong binoculars or a telescope. The former are preferable because the bird can be more quickly sighted and kept in the field of vision. Nothing is more disappointing than inclement weather when one is making careful observations with a field-glass. Rain, sprinkling on the lenses, blurs the objects under observation, and dull weather, even when the binoculars yield excellent light-transmitting power, prevents one from distinguishing many details in plumage-markings. Lastly, a choppy sea spoils the view of birds floating on its surface, by intermittently occluding their outline when they dip into the troughs of the waves.

It must be borne in mind that shore and sea-birds are not dislodged from their accustomed haunts by severe frosty weather, in fact it is under such climatic conditions that some inland species (especially those of aquatic habits, for instance the coot and waterhen), resort to the coast. Why ? *Because, we remember, the coastal temperature is higher than that of inland districts !* Thus when fresh-water lakes and ponds are frozen, their feathered inhabitants betake themselves to the coast. Severe frost (especially when accompanied by high, biting wind), can be very unpleasant for the observer, when crouched on bare, damp sand-flats, patiently studying the panorama of bird-life, which winter-migration presents to his view.

Marine-birds, with the exception perhaps of an occasional party of gulls, never pay our town-gardens a visit : we cannot remain at home in a warm comfortable room and watch through the window ; we must prosecute our studies in the cheery spirit of ardent and thorough-going field-naturalists, and repair to the water's edge to find our feathered friends.

WE REPAIR TO AN ESTUARINE COAST.

" Let's pretend " that it is a mild, genial, calm, bright, day in December, and that we make an excursion to the extensive sand-flats and ooze of a large estuary. Various channels, some branching off from the main river, intersect the ooze-beds. Here the water is so tranquil that it resembles almost a sheet of glass. Observe in the largest channel, a long irregular dark line, half a mile in length ! This line is composed of birds. They are, however, a long distance away, and so peculiarly wary that we cannot approach within close range. Now, as we view them with the naked eye, they are barely discernible as birds. So out and up with your



FIG. 63.—WINTER'S PICTURE OF MARINE BIRD LIFE.

The sand flats and ooze of a large estuary.

"Observe in the largest channel, a long irregular dark line, half a mile in length!.....An impressive scene presents itself! The bulk of the great company consists of ducks.....Do not these geese and swans make a pretty and neat inset in 'black and white' in our gigantic marine picture?"

binoculars and telescopes, my young friends, as quickly as you can ! An impressive scene presents itself ! The bulk of the great company consists of ducks, and we can readily make out several species, for instance we see not a few with long, pointed, tails. They are appropriately named *Pintails* ; those throngs, jet-black in colour with the curious knob at the base of the beak, consist of *Scoters*, myriads of which migrate to the British Isles. Of course you recognise great numbers of *Mallard* (our common Wild-Duck) and a goodly sprinkling of the well-known *Wigeon*. But the different ducks are far too numerous to call for further individual consideration.

Bear in mind : fully eighteen species occur as winter-visitors to our Isles ; the majority of these also breed with us. Look at a small party of *Wild Swans* in that shorter but deeper channel to the right ; and on the adjacent reef of ooze observe a fine large company of blackish birds, which are *Brent Geese*. We can see they are geese with the naked eye, but it is better to use your glasses as their dusky plumage is not relieved by the surroundings.

A PRETTY INSET IN 'BLACK AND WHITE.'

Do not these geese and swans make a pretty and neat inset in 'black and white' in our gigantic marine picture ?

Adult wild swans are white in colour. The difference in size and some minor characters in the beak which serve to distinguish the two common species (which migrate to our shores), need not here be indicated. The two are called respectively the *Whooper* and *Bewick's Swan*. The wild geese which reach our shores are not so numerous in species as the ducks ; most of them exhibit a uniform greyish shade of plumage, but the *Barnacle-Goose* is strikingly handsome in his coat of black

(shading to lavender-grey), and pure white. His congener the brent goose, (smaller in size, and exclusively marine in habits), looks rather mournful as he parades amidst the murky ooze, attired in dull black. The *Snow-Goose* is very different. This fine fellow receives his name because when in fresh feather he appears as white as 'the driven snow.' Alas! he is a rare visitor to the British Isles.

We cannot find any more birds on the tranquil waters of these intersecting channels; we have scanned these areas very thoroughly with the aid of our binoculars.

DIVERS FORMS OF 'DIVERS.'

Let us turn our attention to the estuary of the river itself, where it widens out into the open sea. Hurrah! We are indeed fortunate to observe quite a number of big birds disappearing and coming to the surface again. These are *divers*, of which there are several species. That very large one, with handsome variegated black and white plumage, is known by the name of the *Great Northern Diver*. We also note the *Red-Throated Diver*, named from the colour of its throat: it is a smaller bird. Several Grebes are among these sea-fowl; they are smaller still, and have distinctly glossy, closely-set, silk-like plumage. Their skins were formerly used for trimmings, notably for making muffs. We are glad to know that these birds are not killed in great numbers for such purposes now-a-days. Those big, sturdy, swarthy, coarse-looking birds are *Cormorants*. They capture great numbers of fish, sometimes very large ones, which they can swallow entire. None of these various divers are included among the ducks. They should not be confounded with diving-ducks, some of which we noticed in the channel. Your binoculars are quite strong enough to show (at close range) that the *divers* have

Without Black Tips. ❧



A.—ICELAND GULL, IMMATURE.
(Fresh specimen in the flesh).

"The Iceland Gull....is about the size of a herring-gull, but can at once be distinguished by the absence of black tips to its wings."



(Photos by the Author)

B.—LEFT WING OF SAME SPECIMEN, GIVING A CLOSER AND LARGER VIEW.

"Its summer home....is in the main restricted to Greenland....and westward to the American side of Baffin Bay."

narrow, pointed, beaks. Everyone is familiar with the form of a duck's beak. It is broad and blunt. The beak of the cormorant, however, differs from that of the other divers in having a *hooked extremity*. (Fig. 64, B.)

Several species of *divers* frequent our seas and estuaries during the cold months of the year: some in great numbers. Furthermore, several species breed in our Isles. Of these the cormorant is perhaps the best known. He has a closely allied cousin, the *Shag or Green Cormorant*, smaller in size, and decorated with a beautiful rosette-like crest in the breeding-season. The latter is, however, strictly maritime, and breeds along the sea-cliffs. The cormorant, on the other hand, is often seen searching for fish on inland lakes, and breeds not only on sea-cliffs but also on islands of fresh-water lakes, sometimes on the ground, at other times in trees.

I dare say that you know the *Little Grebe* or *Dabchick*. This elegant small diver is widely distributed as a breeding-species in our Isles, and is not unknown in the vicinity of Sheffield. His larger cousin, the *Great Crested Grebe*, endowed with handsome ear-tufts and neck-frill, which he dons in the nesting-season, also breeds in our Isles. (Fig. 64, A.) Look up quickly at that huge gull sailing past leisurely, and so nice and near at hand! Watch! He is about to alight upon the sands. Surely you hardly failed to observe that his wings, just at the moment before he closed them, and as they stood out in bold relief against the brown 'ribbed sea-sand,' *shewed no sign of black on their tips*. Bear this point in mind: all our common species of gulls which breed in abundance in the British Isles, *display black-tipped wings*. What then is the name of this very strange giant gull, and whence has he come? Note: he is fully equal in size to



A.—GREAT CRESTED GREBE.

"The Great Crested Grebe, endowed with handsome ear-tufts and a neck-frill, which he dons in the nesting-season....breeds in our Isles....Grebes....have distinctly glossy, closely-set, silk-like plumage."



FIG. 64.

B.—CORMORANT.

"Those big, sturdy, swarthy, course-looking birds are Cormorants.... Divers have narrow, pointed, beaks....The beak of the cormorant, however, differs from that of the other divers in having a hooked extremity."

our Great Black-Backed Gull or *Royal Gull*, the latter name being also familiar. (PL. VII. C.D.)

ARCTIC GULLS AND THEIR WANDERINGS.

This strange bird is a *Glaucous Gull*, which has migrated from its home in far-off snow-clad lands. We need not specify any particular countries or even Continents for, wonderful to relate, this hardy bird is resident as a breeding-species during summer throughout the entire *North Circumpolar regions* of the Old and New World. In winter its wanderings take it to the Mediterranean, the Black, and Caspian Seas ; in the Pacific Ocean to Japan and California ; and on the east coast of America to Florida and Texas. The Great Lakes of America are also visited. This gull therefore wanders far and wide in winter from its Polar home, to the sea-boards of the North Atlantic and North Pacific Oceans, approaching within twenty degrees of the Equatorial Line ! Every winter (but only in limited numbers), the coasts of Great Britain and Ireland are visited. (PL. VII. D. Fig. 70.)

The *Iceland Gull* also occurs off our shores as a winter-visitor. It is about the size of a herring-gull, but can at once be distinguished by the absence of black tips to its wings. Its summer-home is not by any means circumpolar ; it is in the main restricted to Greenland, its chief breeding-quarters, and westward to the American side of Baffin Bay. It also finds a breeding-home in Jan Mayen Land. Unlike the glaucous gull, its distribution in winter is confined to Iceland, Scandinavia, and the Faroe Islands, south of which latitudes on the European sea-board it occurs in much more limited numbers. It is only a very casual visitor to regions south of the British Isles. On the American coast it migrates as far as the Great Lakes, its range extending somewhere to about 45 degrees N. Lat. (PL. XXIV.)

LEGIONS OF SANDPIPERS.

But now carefully scan the sand-flats and expanses of soft ooze-beds. Far from being a dreary coastal desert, they are enlivened by the presence of countless numbers of wading-birds. Here *sandpipers* are strongly represented, and, for our purposes, it matters little whether some are not sandpipers in the strictly technical sense, for they are certainly sandpiper-like birds. It is quite sufficient for all practical purposes to regard the lot as *sandpipers*. Which then are the sandpipers, you ask? See! right in front, on either side—in short, you are surrounded by them! Their numbers surely are 'legion'! (Fig. 65.)

Those active and dainty little creatures, racing hither and thither in search of food, they are the sandpipers. Observe! They are nearly always on the move. Just do look at them! Nimble sprites, darting about with lowered heads, probing their beaks intently in the soft estuarine mud. See others lining out like little soldiers along the fringe of the breakers; a few more venturesome than the rest are now wading so deeply that they are almost taken off their feet; others are flitting into the air to avoid the splash of the approaching wave! Observe that some of these delightful little creatures, as they gaily trip along the water's edge, halt momentarily to indulge in the luxury of a plashing and hurried bath. Did you notice that one or two dropped out of the ranks in order to secure a shrimp or worm? Yes; and again away they race after their companions for thirty yards without stopping, as if suddenly propelled by clockwork.

There are several species of sandpipers; the most abundant which visit our shores are probably *Dunlins* (the little fellows which we have been watching), *Knots* which are somewhat larger, and the longer-legged and still larger



FIG. 65.—LEGIONS OF SANDPIPERS.

A ramble on the sand-flats in mid-winter.

"Which then are the sandpipers you ask? See! right in front, on either side—in short, you are surrounded by them! Their numbers surely are 'legion.' Just do look at them! Nimble sprites, darting about.....away they race after their companions for thirty yards without stopping, as if suddenly propelled by clockwork."

Redshanks and *Godwits*. *Curlews*, larger still, with very long decurved beaks, are also plentiful. Study the last-named through your glasses; they are a long way off but wary and suspicious on being approached. Their wild, though sweetly plaintive whistle, however, is audible in the distance.

HARMONIOUS AND DISCORDANT PLUMAGES.

The upper plumage of most shore-birds is greyish-brown and matches the colour of the sands so very closely that even a flock, when standing motionless, may, to a large extent, pass unnoticed. A few wading-birds, for instance, *Oyster-catchers* and *Lapwings* shew strongly contrasted colours in black and white, which render them somewhat conspicuous.

Such then is the magnificent sea-scape of bird-life and winter-migration, which Nature herself paints for us: the thrilling picture is full of many other details, all being of surpassing interest, when more closely examined by the ardent naturalist.

Was it not indeed intensely enjoyable as well as most invigorating to have had this ramble over the sand-flats in mid-winter—thanks to the mild genial day in December which we have been fortunate enough to select?

We must now wend our way homewards, and I shall chat to you about some more points on the subject of migration as we go along the road. Recollect, I mentioned in my opening remarks on bird-migration that land-birds of the high northern latitudes are affected seriously in winter by loss of food and light. In the case of the more hardy shore and sea-birds, it must be remembered that even if they were able to obtain food along the sand-flats and among the sheltered creeks and estuaries (where a milder climate prevails than inland), they must nevertheless push southwards in search of longer day-light.

Venturesome Young Travellers.



A.—REDSHANK.

GREENSHANK.

REDSHANK.

"It is interesting to learn that the most extensive migrations are made by sea and shore birds: indeed amazingly long journeys are undertaken by some species."



B.—GROUP OF TURNSTONES.

(Photos by H. Brooke)

The bird in the centre is an adult in nuptial plumage: the other two are immature.

"The Turnstone...breeding in Greenland, Iceland, Spitz-bergen, and in Arctic Europe and Asia generally, wanders to the coasts of Africa, Asia, Oceania, and Australia!...The most astounding thing is that the journeys are made by young birds when only three months old."

Surely the grand panorama of bird-life which we have just beheld and so thoroughly enjoyed, has proved this to be true. These hosts of aquatic birds greatly swell the list of winter-visitors; nay more, without them the list would be insignificant.

AMAZINGLY LONG JOURNEYS OF SOME AQUATIC BIRDS.

The migrations of aquatic birds from northern regions, fulfil the same purport as those of land-birds. Here it is interesting to learn that the most extensive migrations are made by sea and shore-birds: indeed amazingly long journeys are undertaken by some species. The *Turnstone* for instance, breeding in Greenland, Iceland, Spitzbergen, and in Arctic Europe and Asia generally, wanders to the coasts of Africa, Asia, Oceania, and Australia! The *Curlew-Sandpiper*, another species breeding in the Arctic Zone, actually reaches New Zealand in its winter migrations! The same may be said of the migrations of the *Greenshank*! (Fig. 70. PL. XVI. PL. XXV.)

Such are merely a few examples of the immense flights undertaken by wading-birds in autumn and winter. The most astounding thing is that the journeys are made by young birds when only three months old. These plucky little travellers set out in advance of their parents, and therefore are quite independent of escort!

In regard to web-footed birds, I have already indicated the lengthy peregrinations of the glaucous gull. Such hold good for many of the ducks. Even if the migrations of geese and swans are, generally speaking, more curtailed, they are by no means confined to narrow limits. There is considerable elasticity in the *geographical distribution* of all these birds as winter-visitors, not only in the case of different species but also in individuals of the same species; the *Turnstone*

is a marked example : some members of his kind pull up on reaching the British Isles, while others proceed onwards to Australia ! These studies in geographical distribution are perhaps the most entrancing in the whole story of bird-migration. In our next chapter we shall deal more fully with the purport, or what I propose to term the mission of migration, a fascinating theme, which, in a previous chapter has been already outlined.

CHAPTER XXIV.

THE MIGRATORY MISSION.

MIGRATION IS A TO-AND-FRO MOVEMENT, REGULAR AND RHYTHMIC AS THE EBB AND FLOW OF THE TIDE.

Winter-migrations of aquatic and land-birds, same purport—No birds of the Northern Hemisphere breed in their southern quarters during our winter—Purely winter-visitors—All migratory birds breeding in the Northern Hemisphere quit their true home in autumn and move south—Migratory birds return north to their homes with feverish haste in spring—Summer-residents hasten from more southerly climes to our Isles in spring—Winter-visitors hasten to more northerly climes from our Isles in spring—In both cases for breeding-purposes—Why winter-visitors do not remain in our Isles in summer—Plenty of food — Friendly fraternities — Representative breeding-species—Irrepressible desire to return to native home—Ingrained instinct—Hence, winter migratory chaffinches, blackbirds, thrushes, starlings, and other familiar garden-birds depart north-bound from our Isles in spring—The purport of the to-and-fro movement always the same—Southerly move, no matter where it starts, always for feeding—Northerly for breeding—Variation in range of fly-lines—Many British summer-residents pass north of our Isles—Many British winter-visitors pass south of our Isles — British summer-residents and British winter-visitors coming up from more southerly latitudes pass north of our Isles together in spring—British summer-residents and British winter-visitors descending from more northerly latitudes pass south of our Isles together in autumn—Regular migratory movements of all birds in one category and fulfil the same mission—Rhythm of migration, constant and regular—The migratory impulse, inherited.

I N our opening chapter on the subject of Bird-Migration we learned in a general way the reason why birds migrate, and the general purport of their journeys. Having now proceeded further in our studies regarding the movements of both British summer and winter-migrants,

their fly-lines and variation in range of distribution, let us see if we can frame a general analysis of what, appropriately, may be called the *migratory mission*.

What is the main object of migration? Has it fundamentally a unified object, carried out inflexibly under all conditions, or is it broken up into various unstable purposes, retarded, accelerated, or otherwise controlled, by vagaries of the weather and other influences? The reply is: that migration is *primarily* ingrained in the bird's nature, is compulsory, and is determined independently of all external influences, and that it is represented by two phases, and two only, namely, a movement out for feeding-purposes and a movement home for breeding-purposes. Such is the sole object of all regular movements, and what we may designate the *mission of migration*.

Having thoroughly grasped the object of this mission, we shall be enabled, to establish a classification of migrants, not simply in relation to their movements to and from the British Isles, but also over the entire Globe.

We may now proceed with an analysis of migratory movements.

VISITORS TO SOUTHERN QUARTERS.

We ask: do any migratory birds from northern latitudes breed in these southern quarters to which they resort during the period covering our winter-season, whether they keep to the Northern Hemisphere or cross below the Equatorial Line? We can answer this question without hesitation in the negative: these birds are purely *visitors* to their southern quarters.

Note, they are winter-visitors when they curtail their wanderings to the Northern Hemisphere; they are summer-visitors when they proceed across the Tropics and penetrate

into the Southern Hemisphere. Remember, in the latter the summer-season corresponds to the winter-season in the former. The true home is that region in the Northern Hemisphere whence the migrants first embark on their southern travels, and back to that region they invariably return with feverish haste in the spring.

THE RACE HOMEWARDS.

Why with feverish haste, we may ask ? Recall to mind a statement which I made in a previous chapter, namely : that swallows, swifts, martins, flycatchers, warblers, corn-crakes, cuckoos, and others, (which form the welcome gathering of birds which come to our Isles for the summer), travel up from their southern quarters with feverish haste, to reach home, build their nests, and rear their families. Well then, the birds (and here it matters not whether we are considering the movements of aquatic or land-species ; of little garden companions or of great sturdy sea-fowl), which visit our lands and elsewhere in winter, as well as those which undertake immensely longer pilgrimages, and enjoy a second summer by migrating beyond the Tropics, are all actuated by exactly the same impulse, namely, to speed northward in spring *post-haste* so as to reach home, build their nests, and rear their families.

Away, then, from our Isles these winter-visitors depart at the approach of the breeding-season in spring. Very exceptionally will an odd straggler, through physical unfitness, be obliged to remain behind ; all others speed north for home, with feverish haste.

Now this exodus must surely strike us at first sight as somewhat remarkable, seeing that such splendid opportunities are afforded for nesting-sites ; and also that friendly



A.—CHAFFINCH.



B.—BRAMBLE-FINCH.

"The bramble-finch is a purely winter-visitor, and the chaffinch is a winter-visitor and a British breeding species; likewise the redwing is a purely winter-visitor, and the song-thrush is a winter-visitor and also a British breeding species."



C.—SONG-THRUSH.



D.—REDWING.

FIG. 66.—FRIENDLY FRATERNITIES.

"These purely winter-visitors freely fraternise...with their respective near relatives, the chaffinch and song-thrush. Hence, if bramble-finches or redwings elected to remain and breed in our Isles we may surmise that chaffinches and song-thrushes would offer no objection."

relations exist in many cases between our visitors and the breeding species.

FRIENDLY FRATERNITIES.

The brotherhood of birds frequenting the British Isles in winter is in many ways firmly cemented, for reasons not difficult to comprehend. In the first place we remember that several species among our winter-visitors happen also to breed in our Isles: for instance, blackbirds, song-thrushes, starlings, chaffinches, robins, larks, gulls, several species of ducks, sandpipers, and other wading-birds.

The northern visitors of these British breeding-species therefore form a friendly fraternity, and would not be driven out if they attempted to remain and breed. But no; their ingrained migratory instinct impels them to take their departure and return to their native homes in more northerly latitudes. Hence, winter chaffinches, robins, blackbirds, song-thrushes, and so on, one and all leave our Isles in spring. In the second place, several species which come to us in winter, *not represented by breeding-species in our Isles, happen nevertheless to be closely related to such breeding species.* For example, the bramble-finch is a purely winter-visitor, and the chaffinch is a winter-visitor and a British breeding-species; likewise the redwing is a purely winter-visitor, and the song-thrush is a winter-visitor and also a British breeding-species. (Fig. 66.)

These purely winter-visitors freely fraternise on most friendly terms with their respective near relatives, the chaffinch and song-thrush.

Hence, if bramble-finches or redwings elected to remain and breed in our Isles, we may surmise that chaffinches and song-thrushes would offer no objection.

THE MIGRATORY MISSION FORMULATED.

I think that you all are in a position now to understand that it matters nothing whether we are considering the northern movements of birds which come to us in spring and remain to breed, and their southern movements as they depart from us in autumn ; or the southern movements of birds which come to us in winter, and their northern movements, as they depart from us in spring ; the object of the to-and-fro movements is in all cases essentially the same in purport. The southerly move, no matter whence it commences and whither it terminates, is carried for feeding-purposes ; the northerly move for breeding-purposes.

Such then is the great and fundamental migratory mission. Furthermore, bear this fact in mind : (which resolves itself into a migration formula) all migratory birds breeding in our Hemisphere seek out the northern limits, and having bred, move off again to spend *our winter-season* in the southern limits of their migrations. Likewise, do not forget that, on the other hand, the geographical distribution of individuals belonging to the same species varies in an astonishingly marked degree.

Many swallows, swifts, warblers, and other purely insectivorous birds, proceed far beyond the British Isles when journeying northwards in spring, and seek out their breeding-homes in Scandinavia and other parts of Northern Europe : so do many redwings and bramble-finches in coming up from Southern Europe—all these birds are bent on the same most important mission. But while some swallows, swifts and warblers pull up and remain to breed in the British Isles, it is otherwise with the redwings and bramble-finches which have their main breeding-quarters far to the north of the British Isles.

The latter two species therefore only touch our Isles *on passage*, and occur perhaps for a day or two, chiefly along



A.—WOOD-WARBLER.

"Many...purely insectivorous birds, proceed far beyond the British Isles when journeying northwards in spring...some...pull up and remain to breed in the British Isles."



B.—GARDEN-WARBLER.

FIG. 67.—MIGRATORY MOVEMENTS OF INSECTIVOROUS BIRDS.

"We find that...purely insectivorous birds, after leaving their breeding-haunts in Scandinavia and other regions of Northern Europe, in autumn, only touch our Isles when en route for their southern quarters, or at the most, remain for a short period."

the coast-line. They may however join up with the outgoing bramble-finches and redwings travelling north, which spent their winter in our Isles.

On the other hand, we find that swallows, and other purely insectivorous birds, after leaving their breeding-haunts in Scandinavia and other regions of Northern Europe, in autumn, only touch our Isles when *en route* for their southern quarters, or at the most, remain for a short period, chiefly along the coast-line.

NATURE OF FOOD AND MIGRATORY MOVEMENTS.

Obviously, from the very nature of their food (flies, gnats, and other winged-insects), such birds could not remain with us for the winter. They may, however, join up with the outgoing swallows and other insectivorous species travelling south, which spent their summer in our Isles, all being passengers for the sunny southern climes.

Many redwings, bramble-finches, and for that matter several other species already mentioned, which breed in high northern latitudes, pass beyond the British Isles, when journeying in autumn, to take up their winter quarters in Southern Europe or other warmer climes. However, unlike swallows, and other purely insectivorous birds, some redwings, bramble-finches and others do pull up and remain for the winter in the British Isles. The reason is not far to seek: in the first place as the breeding-areas are *mainly confined to high northern latitudes*, these sturdier travellers find the climatic conditions of the British Isles quite suitable to their wants; and secondly, and this is a more important point, redwings and bramble-finches are not dependent upon insects exclusively for their food, hence they can find a sufficient supply of worms, grubs, snails, berries, grains, seeds, and other materials which constitute their varied *ménu*.

It is quite evident then that the food-question is largely responsible for the wide variation in the range of distribution of migratory birds.

We have now cleared the ground sufficiently to enable us to frame a classification of migrants, not only in regard to their relations to the British Isles, but also to far-distant regions of the Globe.

BIRDS-OF-PASSAGE.

We have incidentally referred to birds touching our Isles for a very short period *en route* for more northerly or southerly latitudes. These passage-movements will form an important section in our next chapter. We shall see that not only are the *birds-of-passage* the most numerous set of migrants as far as our Isles are concerned, but also their occurrence affords us the strongest clue that all migratory movements, in their ultimate analysis, fulfil one supremely important mission. We shall see, that birds-of-passage, which touch the British Isles, also sweep in a great wave over a wide area of the European Continent, and these travellers can be recorded from hundreds of observatories, from any of which we are afforded evidence of the uniformity of the migration mission.

On the contrary, we shall see that our classification of other migrants is, at most, arbitrary, and is only relative to the outlook of bird-migration as it affects the British Isles.

LECTURE 16.

CHAPTER XXV.

CLASSIFICATION OF REGULAR MIGRANTS.

THE BIRDS-OF-PASSAGE CARRY THE MESSAGE OF MIGRATION.

Classification of British migrants based on differences in geographical distribution—British and Continental winter-visitors placed in same category—British and Continental summer-residents placed in same category — Restricted migrations — Winter-visitors and summer-residents to British Isles represented by same species—Inter-British migrations—Stationary individuals of British migratory species—Song-thrush and other species, included among several classes of migrants relative to British Isles—Resident—Inter-British migrant—British summer-resident — British winter-visitor — British bird-of-passage—Birds-of-passage—A very numerous throng—Why so strongly represented in the British Isles—Situation central—Junction, not terminus—Many coastal routes—Hosts of birds-of-passage, representatives of our summer-residents and winter-visitors, touch the sea-boards of Great Britain and Ireland — Purely passage-birds — Not represented by British breeding-birds or winter-visitors — Various classes appear—Examples—White Wagtail—Greenland Wheatear—Wading-birds—Passage migrants stop off in high Arctic and Tropical Zones—Summer-residents in Arctic Regions very dominant—Likewise winter-visitors in Tropical Regions—Birds-of-passage, most widely distributed of their species—A migration formula—‘Further a bird breeds north, further south it winters’—Double winter-migration—Hard-weather movements—Second move also for feeding—Two winter moves in same category as one—Steps to first winter-quarters not retraced—Home flight taken by shortest route with feverish haste—Original emigration—Outward journey, a repetition—Original immigration — Homeward journey, a repetition — Migration, to-and-fro

movements—Immigration—Emigration—Rhythmic and hereditary—Implanted — Age-long practice — Desire to migrate instinctive—Migrations of birds native to Northern Hemisphere, studied as a whole — Classifications of British migrants, quite arbitrary and purely relative—Movements of birds-of-passage prove that bird-migration must not be studied locally — Partial-migrants — General — British — Included in category of summer-residents—Some individuals, stationary—Classification summarised.

I DO not propose taking you out for a ramble to-day, my young friends, because we have now a number of interesting points to clear up in regard to the question, as to how we are going to classify our migratory birds. So we must be content to stay indoors and study this interesting part of our subject diligently. Never mind, we have had recently several enjoyable rambles and pictures of bird-life in the open. From what you have already learned, it becomes quite clear that our classification of winter-visitors and summer-residents, in so far as these travellers affect the British Isles, is based upon, indeed we may say is the outcome, of those marked variations which we have seen take place in the geographical distribution of individual species. Let me cite an extreme case: Mr. Turnstone (*a*) and Mr. Turnstone (*b*) both start from somewhere in Arctic Europe, say from Spitzbergen. Mr. Turnstone (*a*) pulls up on reaching the British Isles and gives us the pleasure of his company during the winter; Mr. Turnstone (*b*) resolves to continue his journey to Australia! What a wonderfully striking difference in geographical distribution in the same species is here presented. But note! Supposing for a moment that *all* swallows (some of which we know do come to us and stay for the summer), and that *all* redwings (some of which do come to us and stay for the winter), bred and spent their summer in the latitudes say of Northern Scandinavia, and that they spent their winter in the latitudes say of Southern

Europe or Northern Africa (which many individuals of these two species actually do), well then our classification of them into *British* winter-visitors and *British* summer-residents, would come to an end. At most these birds might be included in our British list as *passage-migrants* in spring and autumn ; and then mind you, provided only that they travelled by way of the British sea-board. If the British Isles happened to lie quite outside their migratory-routes, then obviously neither swallow nor redwing could claim inclusion *at all* in the British list. However it so turns out that they *are* included as passage-migrants, and bear in mind, migrants which are included in exactly the same category. Both occur as birds-of-passage along our sea-board and elsewhere in Europe in spring and autumn.

PASSAGE-MIGRANTS IN SAME CATEGORY.

Among the tens of thousands of swallows and redwings which journey in spring from Southern Europe to Scandinavia and to other areas in Northern Europe, there are many which come our way and pay us a passing visit. Likewise among the tens of thousands of swallows and redwings which journey in autumn from Scandinavia to Southern Europe and beyond to the African Continent, there are many which come our way and pay us a passing visit.

So far then, so good ! redwing and swallow bear the exact same relation to one another in their passage-movements as far as the British Isles are concerned. In classifying we cannot separate them ; they both fall naturally under one heading or category, namely, '*birds-of-passage to the British Isles in spring and autumn.*' But notice how the food-question together with other factors in the bird's life, react upon their geographical distribution. We have

already seen that some of the redwings on their southern travels in autumn on reaching our shores *do not pass on* ; there are food-rations to be had, hence the winter is spent with us, and we catalogue these birds as *British* winter-visitors.

BRITISH MIGRANTS ONLY A BRANCH-LINE.

But we must never forget that our Isles are a very small spot on the Globe, and that they can afford hospitality only to a very small fraction of the myriads of redwings which, on the approach of winter, set out on their travels in search of food and shelter. Viewing the southern migratory movements of the redwing, not merely as they affect our Isles (which would be an isolated, narrow, and unprofitable view to take), but also many other lands, it is clear in this wider prospective, that it is impossible here to dissociate the migrations of British redwings from those of Dutch, French, Spanish, Italian, and even North African redwings. All are included in the category of winter-visitors. When the spring returns, the breeding-factor will react upon geographical distribution, and, with one accord, the birds from all these countries and from others, will face about and set out on their travels, steering for their homes in Northern Europe and Asia.

Such then is our analysis of the migratory movements of the redwing, and we know now that very many other birds, whose homes are wholly or in part in high latitudes, and who, finding food available, *occur* as winter-visitors to the British Isles. Again, remember that only small percentages of each species halt and sojourn ; most of the vast hordes pass along to reach lower latitudes. *British winter-visitors then differ only in degree not in kind from all other south-bound migrants, in that finding food and climate available, they curtail their journey.* Cut off their winter-supplies, and then their

The Western Sea-board of Europe and Bird-migration.

EXPLANATORY KEY TO FIG. 68. (MAP).

The migratory routes, also known as 'fly-lines,' are indicated by *dotted lines*.

Multitudes of birds, when seeking out their destinations, avail themselves of the coast-line. *The western sea-board of Europe* constitutes the main route along which vast streams of migrants push northward in spring and southward in autumn.

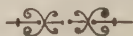
A glance at the map shews that the British Isles are not only completely encompassed by fly-lines, but also that many junctions are effected between Great Britain and Ireland, more particularly where the coasts of Ireland and Scotland closely approach. Here, across narrow stretches of water, the fly-lines of *inter-British migrants* are well-defined.

Branch-lines, traversing the English Channel and North Sea, take the travellers to and from the Continent.

Iceland and Greenland are reached by a branch-line which passes through the Orkneys, Shetlands, and Faroes. A more westerly route connects the Hebrides directly with the Faroes; thence it is continued to Iceland. Birds travelling along the western sea-board of Ireland usually follow this fly-line.

British birds-of-passage strike a dominant note. They sweep past both the eastern and western sea-boards of our Isles, at times in immense numbers. The Irish and Scottish contingents become confluent in the Hebridean areas. To these indefatigable travellers, the British Isles, owing to their latitudes, represent a great junction rather than a terminus.

Some birds quit the Mediterranean sea-board, and thence travel overland, chiefly along the river-beds of the European Continent. The route along the Rhone Valley is depicted in the map.



The Western Sea-board of Europe and Bird-migration.



FOR EXPLANATORY DETAILS SEE KEY ON PAGE 362.

than a terminus. Here indeed they may well be compared to a great junction where hosts of migrants converge and then continue to travel on branch-lines towards their respective wide-spread destinations. The usual route to Iceland, *via* the British coast, Orkneys, Shetlands, and Faroes, is, for instance, a well-marked branch-line. In longitude the British Isles are likewise favourably situated for witnessing the movements of hordes of migrants, because their coast-lines take part in the constitution of the *general western sea-board of Europe*. (Fig. 68.)

Remember, the vast majority of birds prefer to follow the coast-line when practicable; hence in spring the British Isles receive a very large percentage of the vast stream of *passage-migrants* which journey northwards along the sea-boards of Spain and France.

Reaching the English Channel, the hosts of travellers (which may elect to cross the water) split up on touching the British coast. Some proceed northwards by the Irish coast, others pass along the English, Welsh, and Scottish coasts. The majority however pursue their migrations along the eastern side of Great Britain, thence across the North Sea to the western side of Scandinavia. This is the main line by which birds-of-passage reach the Continent *en route* for northern latitudes, and these birds form a remarkably strong contingent of migrants. Considerable numbers reach Continental Europe directly, by travelling inland from the coasts of France, Belgium, and Holland. Such birds do not, as a rule, touch the British Isles. In autumn the return journey is, in a great measure, retraced. (Fig. 68.)

Truly, the birds-of-passage are by far the most numerous, both in regard to species and also individually. This is readily understood when we keep before us clearly the fact

that hosts of individuals belonging to the great majority of species which sojourn in our Isles in summer and winter, visit our shores on passage. In point of fact they form the bulk of such migrants.

PURELY PASSAGE-MIGRANTS.

In addition there are many species drawn from various classes which occur *strictly as birds-of-passage along our coasts only in spring and autumn.*

Among the commoner species included in this category may be mentioned the *White Wagtail*, the *Greenland Wheatear*, also *Northern Races* of some of our well-known *Warblers*, together with some of our *Wading-Birds*, grouped collectively as *Sandpipers*. (PL. XXVI.)

The birds-of-passage therefore strike a singularly dominant note in regard to our studies of bird-migration. As already pointed out, it is the geographical position of our Isles which greatly favours the presence of all these birds. Were we to live well inside the Arctic or Tropical Zones, our studies of passage-migration would deal with far fewer species; on the other hand, the throngs of summer-migrants returning to their northern homes, and the winter-migrants moving out to their southern quarters, would afford us extensive observations of bird-migration. Some birds-of-passage actually rush past our Isles: we may venture to compare these to a long-distance non-stop express train; however their migrations indicate the same purpose and are subject to the same laws as already indicated in the case of summer-residents and winter-visitors.

Even some of our familiar garden-birds, such as black-birds and thrushes, when migrating northwards from southern latitudes, say from Spain, to breed in Scandinavia, impinge

❧ Purely Passage=Migrants. ❧



WHITE WAGTAIL.

"There are many species, which occur strictly as birds of passage along our coasts—in this category may be mentioned the White Wagtail, the Greenland Wheatear, also Northern Races of some of our well-known Warblers."



GREENLAND WHEATEAR.

(Photos by the Author)

"The birds of passage... strike a singularly dominant note in regard to our studies of bird migration—it is the geographical position of our Isles which greatly favours the presence of all these birds... To vast multitudes... our Isles represent a highly important station en route, rather more than a terminus."

upon our coast-lands, though practically without alighting. Obviously, such individuals among these species in migrating very long distances, shew a specially extensive distribution. Speaking generally, birds-of-passage affecting our Isles are the British individuals which have the most extensive distribution of their respective species. It may be formulated as a fundamental principle of bird-migration that *the further a bird breeds north, the further south it migrates during our winter months, within the limits of its geographical distribution.*

A COLD SNAP OF WEATHER INDUCES A SECOND WINTER MOVE.

There is still another phase of migration, which, although it might appear at first sight highly irregular, nevertheless it falls strictly into line with the primary purport of all regular migrations. We know that birds depart from their breeding-haunts at the approach of the winter-season in search of food: sometimes it so happens that before the winter is over, the food gives out in certain districts. Very inclement weather generally causes the famine. A *second winter-migration* therefore becomes necessary, remember, *purely for feeding-purposes.* If the birds can obtain food enough in their new quarters for the rest of the winter, then, when setting out for their breeding-homes, they do not necessarily retrace their steps to their former winter-quarters. Why? Surely because they desire to reach their homes with feverish haste, and therefore by the shortest possible route. For example: we find birds which, on leaving their breeding-quarters in Northern Europe, had intended to pass the winter in Central Europe, but, owing to an unusually cold turn in the weather, they were driven, from lack of food, to embark upon another trip.

THE EAST TO WEST MOVEMENT AND THE GULF-STREAM.

As this route is often directed from *east to west*, we may follow the migrants on such a journey to their destinations along the south-western sea-boards of Great Britain and Ireland, where it would appear that the influence of the Gulf-Stream, especially in regard to Ireland, renders the climate much milder. The latitudes of these new winter-quarters are frequently *higher* than those whence the birds departed in Central Europe, nevertheless they remain warmer owing to Gulf-Stream and coastal influences.

Is it not remarkably interesting to think of these travellers in their second winter-migrations bearing *northwards* as well as *westwards* in search of milder climates? Having fared well in these quarters and the winter being over, how will the birds reach Scandinavia? By the shortest possible route. Will they return to Central Europe? Surely not; their vernal journey is not in search of food but of breeding-sites: they are bound for *home*, and will make for it by the shortest *inter-British, North Sea, 'bee-line' route*.

Despite the fact that these migrants were forced to spend part of the winter in one country and part in another, they originally set 'sail' from their breeding-quarters in Northern Europe in search of food, and returned again to their breeding-quarters *post-haste* at the appointed time. Their migrations therefore cannot be looked upon as departing from the fundamental law which prevails in regard to birds which breed in the Northern Hemisphere.

To summarise: here is the essence of the migration-law. All migratory birds, which breed in the Northern Hemisphere, set out from their homes at the close of the breeding-season to search for adequate sustenance—let us call this movement the *outward journey*; a repetition of an

original *emigration* undertaken by the forefathers of our birds in dim past ages, when migration first began. All migratory birds breeding in the Northern Hemisphere return *post-haste* to their homes instinctively at the appointed time—let us call this movement the *return journey*; a repetition of an original *immigration* undertaken by the forefathers of our birds in remote past ages, when migration first began. Through being oft-repeated, these *immigratory* and *emigratory* (*in other words, to-and-fro*) movements became in time so deeply planted that now they are *rhythmic* and *hereditary*.

MIGRATION RHYTHMIC AND HEREDITARY.

Migration, which is after all the combination of the *emigratory* and the *immigratory* movements, has consequently become rhythmic and hereditary. The migrations carried out by summer-residents, winter-visitors, and birds-of-passage, as well as the various local movements made by inter-British migrants, are all essentially phases of two seasonal movements only: one made in spring when all birds of our Hemisphere move north to their breeding-haunts, where the entire summer is spent; the other in autumn, when all birds of our Hemisphere move south to their feeding-grounds, where our entire winter-season is spent.

A LOCAL AND PECULIAR MEANING.

Our classification of birds into British winter-visitors and British summer-residents presents but a local and peculiar meaning. It is quite an arbitrary classification and relative only to the outlook of bird-migration as it affects the British Isles. But as the migrations of the birds of the Northern Hemisphere must be studied as a whole, it is quite obvious that the different phases of British bird-migration cannot

be considered as a thing apart : by no means can we enclose these phases, so to speak, in a water-tight compartment !

Supposing for a moment that we view the aspects of bird-migration from the standpoint only of the British Isles, even then we learn that the movements of the birds-of-passage reveal the fact that they come under the fundamental law of migration. Indeed, when we study the movements of the birds-of-passage, we are really compelled to view the migrations of the birds of the Northern Hemisphere as a whole, that is to say, as they affect other countries also, and not as a mere local measure.

PARTIAL BRITISH MIGRANTS.

Our classification of regular migrants would be incomplete if we omitted to include those birds which are termed *partial British migrants*. What then do we mean by partial migrants ? Let me explain. There are large numbers of birds (and, by the way, many of them are very familiar species), of which some in a given species migrate, while others remain stationary. The song-thrush is truly an excellent example. Some individuals are stationary in our Isles the whole year round : others migrate within the limits of the British Isles. Again, some individuals are *stationary* in more northern climes, while others migrate from these regions to the British Isles in winter, and return to these regions to breed in summer. Again, some individuals are stationary in more southern climes, while others migrate from these regions to the British Isles in summer, where they breed and then set out for their more southern quarters at the approach of winter. Lastly, there are migratory individuals (of those stationary birds which breed either north or south of our Isles), which may merely touch our coast-lands on passage, when they are moving northwards or southwards. The rook, the starling, the wagtail, the

"It is wonderful to think that the song-thrush, the blackbird, the wagtail, the starling, the robin, and



A.—SONG-THRUSH.



B.—PIED WAGTAIL.

several other familiar birds, can be represented in our Isles by stationary-

residents, summer-residents, winter-visitors, inter-British migrants, and by the birds-of-passage."



C.—BLACKBIRD.

FIG. 69.—PARTIAL MIGRANTS.

blackbird, the robin, and many others, are also examples of species which include partial migrants. It is quite clear that the migratory races of these thrushes, in so far as they affect our Isles, fall naturally into the category of winter-visitors, summer-residents, and birds-of-passage, to which we may add those which move to-and-fro within the limits of our Isles, and which we classed as inter-British migrants. Now take the case of a song-thrush, which is a summer-resident in our Isles. Can we class it exactly in the same category with the swallow, the cuckoo, the corn-crake, the swift, the flycatcher, and many species of the warblers, all of which are summer-residents also, but are better known in popular parlance as summer-migrants or summer-birds? No, because the swallow is not, in addition, a partial migrant; *none of the individuals are stationary*, at any rate as far as our Isles are concerned. The same applies to the other summer-birds above mentioned.

Again, let us take the case of a song-thrush, which is a winter-visitor to our Isles. Can we classify it exactly in the same category with the redwing and the field-fare (which as a matter of fact happen also to be thrushes), or the bramble-finch, all of which are familiar winter-visitors? No, because these birds are not, in addition, partial migrants, none being stationary as far as our Isles are concerned. All of them leave our Isles at the approach of summer and return to their homes in more northern latitudes. Stationary forms of these birds may however exist within the confines of their breeding-areas. That of course is quite another matter.

It is wonderful to think that the song-thrush, the blackbird, the wagtail, the starling, the robin, and several other familiar birds, can be represented in our Isles by *stationary-residents, summer-residents, winter-visitors, inter-British migrants,*

and by the *birds-of-passage*. The determining factor in these cases depends upon the degree to which the individuals are favoured in their surroundings in the search for food and in other exigencies of life. Obviously then, the more favoured individuals, with '*private means*' and removed from enemies, can stay at home with greater chances of success. (Fig. 69.) Such then is the *classification of regular migrants* which have their homes in the Northern Hemisphere.

Birds who have their homes in the Southern Hemisphere are also, to a very large extent, migratory.

Moreover, as we should expect, their movements are mainly rhythmic, regular, and full of interest, particularly from the seasonal as well as the geographical view-point. These, and several other particulars, will be laid down in the following chapter.

LECTURE 17.

CHAPTER XXVI.

MIGRATIONS OF BIRDS NATIVE TO THE SOUTHERN HEMISPHERE.

Birds which breed south of the Equator—Seasons reversed—Tropical and Sub-Tropical species stationary, or restricted in their migrations—Many birds of South Temperate and Antarctic Regions perform extensive migrations—Direction of movements—Approach of the southern winter, northwards—Approach of the southern summer, southwards—Mission—Northerly movement for feeding-purposes—Winter-visitors—Southerly movement for breeding-purposes—Summer-residents—Northerly route taken by the outward-bound migrants—Southerly route taken by the homeward-bound migrants—Outward-bound birds, winter-visitors, from the Northern and Southern Hemispheres, converge and even overlap at Tropics—Homeward-bound birds to the Northern and Southern Hemispheres diverge—Separate widely *en route* for destinations—Some native aquatic species on migration keep within the confines of the Southern Hemisphere—Penguins—Albatrosses—Others, also natives of the Southern Hemisphere, penetrate far into the Northern Hemisphere—Shearwaters—Description—Flight—Breeding-distribution, far south—New Zealand and other localities—Wander on migration to fringe of the Arctic Circle—Many land-birds from Southern Hemisphere cross Equator when moving north, and overlap birds from Northern Hemisphere when moving south—Both groups of migrants are outward-bound winter-visitors, which converge and overlap—Summer-residents to either Hemisphere reverse the movements and widely diverge.

WE have followed carefully the migratory movements of birds which breed in the Northern Hemisphere. We learned that some species are so widely distributed that they are circumpolar, or nearly so, in their breeding-range. Others, though more restricted, nevertheless spread

eastward, so that their fly-lines in spring from the African Continent reached the northern areas of Asia as well as Europe. We have however been mainly concerned with birds whose breeding-sites are restricted to the European region of the Old World. Presently we shall follow the fly-lines and distribution of those migrants which essentially belong to the American Continent and which breed in the Northern Hemisphere of the New World.

MIGRATIONS OF BIRDS NATIVE TO THE SOUTHERN HEMISPHERE.

But in the first place it is necessary to look into the migrations of those birds which are natives of the Southern Hemisphere, in other words, which always move in a southerly direction when seeking out their breeding-quarters. We shall then be in a much better position to make a general survey of the migratory movements of American birds in regard to their breeding-quarters in regions of either the Northern or Southern Hemispheres of the New World.

Let me now ask a leading question: Is the purport or mission of migration the same in the case of birds which are native to the Southern Hemisphere as it is in the case of those native to the Northern Hemisphere? Yes: birds fly towards their breeding-haunts at the approach of the southern summer, and fly from their breeding-haunts at the approach of the southern winter.

Note, however, the directions of the migratory flights are just the reverse of those taken by birds breeding in the Northern Hemisphere. Migrants returning to their breeding-quarters in the Southern Hemisphere, fly in a direction from north to south, while their outward journeys for feeding-purposes are directed from south to north. In Tropical

Regions the fly-lines of birds from both Northern and Southern Hemispheres not only meet, but in many cases overlap. We must bear in mind that some species, which have their homes at a comparatively short distance from the Tropics, only migrate short distances. Food is abundant all the year round, and there are also many suitable nesting-haunts. But quite extensive migrations are accomplished by very many species which breed in the South Temperate and Antarctic Regions.

Let us now be perfectly clear in regard to the direction and purport of their movements. The birds move northwards for feeding-purposes at the approach of the southern winter ; whereas the birds breeding in the Northern Hemisphere move southwards for feeding-purposes at the approach of the northern winter. At the approach of the southern summer the birds breeding in the Southern Hemisphere proceed southwards to their homes ; whereas at the approach of the northern summer, our birds of the Northern Hemisphere journey northwards to their breeding-homes.

Observe, some sea-birds, although migratory, keep within the confines of the Southern Hemisphere. Penguins and albatrosses are familiar examples. It is only on very exceptional occasions that an albatross will venture across the Equator, although, strange to relate, stray individuals have actually been recorded from British waters.

THE VAST WANDERINGS OF SHEARWATERS.

On the contrary, there are certain birds of the Southern Oceans which penetrate far into the Northern Hemisphere during our summer season.

For instance, the *Great* and the *Sooty Shearwater*, may be seen in large numbers in our summer months scattered

One of a Wandering Tribe.



MANX SHEARWATER.

(Photo by the Author.)

The name "shearwater" has been given because the bird skim over or "shear" the tops of the waves. The common form of the Manx Shearwater is the Manx Shearwater, in which the wings are "sheared" the twigs, it shows the flapping-movements and gracefully glides on motionless pinions."



over the vast waters of the North Atlantic Ocean. They may be watched with facility from the deck of an Atlantic Liner ; indeed these birds, by their markedly graceful and buoyant movements, as they skim through or just clear the waves, usually attract the attention of the passengers.

The name '*shearwater*' has been given because the birds skim over or 'shear' the tops of the waves. Shearwaters, as a race, exhibit dark upper and white under plumage. The sooty shearwater is an exception, and, as its name suggests, is clad in a sombre suit of dusky-brown. The common species found in British waters and breeding in many localities round our coasts, is well-known as the *Manx Shearwater*. The flight is so characteristic that the bird cannot be mistaken. When clear of the waves, it takes half a dozen rapid flaps, its wings being spread widely, then, in cutting into or *shearing* the breakers, it stops the flapping-movements and gracefully glides on motionless pinions. (Pl. XXVII.)

The shearwaters of the Southern Hemisphere have their homes on the coasts and adjacent isles of New Zealand ; also in the neighbourhood of Cape Horn, and other areas of the Southern Continents.

In their peregrinations these oceanic birds actually reach the fringe of the Arctic Circle in considerable numbers.

The *Arctic Tern* penetrates far *north* as a breeding-species and wanders away far south during our cold season. Observe the reverse movements : the Great and the Sooty Shearwater penetrate far south as breeding-species, and wander away far north during our summer months.

Hosts of land-birds, large and small, breeding in Southern New Zealand and the contiguous islands, move north at the approach of the southern winter ; in like manner our European birds breeding in the Northern Hemisphere move south at

the approach of the northern winter. Many New Zealand and South Australian birds cross the Equator in pursuing their northerly migrations; in like manner our European birds cross the Equator in pursuing their southerly migrations. In both cases the birds are outward-bound, that is to say, travellers moving from their breeding to their feeding-quarters.

CONVERGENCE AND DIVERGENCE.

It is in the *outward-bound routes* that we find *convergence* taking place between migrants from the Northern and the Southern Hemispheres. Not only convergence but indeed considerable overlapping. The *homeward-bound routes* *diverge* and separate widely from one another.

It is an excellent plan to procure some blank maps of the world, and then to draw in the migratory-routes in two colours; those representing convergence towards the Tropics in red; those representing divergence towards the Polar Regions in green. This is a nice and an interesting, as well as a most instructive way of learning some geography.

If we keep uppermost in our minds the wonderful journeys of the birds, some made by frail and fairy forms, this method of adding to our knowledge of map-geography becomes still more interesting. (Figs. 54, 68, 70.)

In the next chapter the regular fly-lines and distribution of American migrants will be considered.

CHAPTER XXVII.

THE FLY-LINES AND DISTRIBUTION OF AMERICAN MIGRANTS.

New World migrations—Vast extent in latitude of entire American Continent—North, Central, and South America, continuous land—Migratory movements of the New World birds breeding in Northern Hemisphere comparable to those of the Old World birds—Important geographical difference—New World penetrates deeper into Southern Hemisphere than Old World—Migrants native to Southern Hemisphere more strongly represented in South America than in South Africa or India—Birds of entire American Continent converge during outward-bound travels and diverge during homeward-bound travels—Fly-lines of American birds, overland and coastal—Pursue a beaten track—Migratory-routes of some oceanic birds ill-defined—Scatter far and wide over the oceans—Trans-Atlantic flights of other birds very exceptional—Migrants which stray far from well-defined American fly-lines are classed as Irregular or Accidental visitors on reaching our shores.

WE are now in a position to turn our attention to the migratory movements of the birds inhabiting the Far West ; that is to say, the Continent of America. It is inspiring to contemplate on the vast extent of latitude with which we are here confronted : for remember, my dear young friends, that the entire American Continent stretches from *Arctic Canada to Cape Horn* ! True, except for the recent formation of the Panama Canal, we are presented with an immense stretch of continuous land, known geographically as North, Central, and South America. Here migration is, for the most part, comparable to what takes place over another vast stretch of land—also nearly continuous—namely, the combined Continents of Europe and Africa.

Thus, multitudes of birds from Equatorial South America and Sub-Tropical Central America press northwards (keeping chiefly to the coast-lines *en route*), to reach their breeding-sites in Temperate and Sub-Arctic North America, that is to say, in the latitudes of the United States and of Canada. Comparable to the Old World migrations, we find here also marked elasticity in the range of geographical distribution: this maintains even among individuals of the same species.

OLD AND NEW WORLD MIGRATIONS COMPARABLE.

These movements of American birds set in much about the same time of the year as those of our familiar species which journey north to their breeding-quarters in Europe and Asia, from Equatorial and Sub-Tropical Africa, and also from Southern Europe. Here then we observe that at the approach of the northern summer, the feathered tide *flows for home* in both Old and New Worlds. In the temperate or intermediate latitudes, summer-residents arrive; winter-visitors depart; and birds-of-passage dash past or, at most, tarry only for a brief spell.

At the approach of the northern winter, we observe next that the tide starts to ebb; the breeding-homes are relinquished; the migrants face about and betake themselves—outward-bound—to quarters available for feeding-purposes, and suitable in climate. In the temperate or intermediate latitudes, summer-residents depart; winter-visitors arrive; and birds-of-passage touch upon the coast-lands or sojourn for a short time. Old and New World migrations therefore are comparable.

At this juncture however, a most interesting difference, from the geographical point of view, arrests our attention.

The immense American Continent, taken as a whole, penetrates far deeper than the African Continent into the Southern Hemisphere. Thus, Cape Horn extends to Lat. $55^{\circ} 55''$ S., whereas the Cape of Good Hope only reaches Lat. $32^{\circ} 00''$ S. Consequently migratory birds make their breeding-homes in much larger numbers in the Southern Hemisphere of the American than in that of the African Continent.

In both of these vast areas there are of course thousands of tropical, and also sub-tropical stationary species; but in the Temperate Regions of South America far greater proportions of migratory birds breed than in Temperate South Africa, the latter measuring a much more limited area.

EXTENSIVE MOVEMENTS IN SOUTH AMERICA TO SOUTHERN BREEDING-GROUNDS.

In South America quite extensive migrations in the Southern Hemisphere take place, in which the migrants travel northwards, when outward-bound, towards (and even beyond) Tropical South America at the approach of the southern winter, and they return southwards, homeward-bound, to Temperate South America at the approach of the southern summer.

Again we are struck with the fact that in regard to the entire American Continent it is in the outward-bound routes that we find convergence taking place between the migrants of the Northern and Southern Hemispheres; not only convergence but considerable overlapping. As in the case of the Old World migrations, the homeward-bound migratory-routes diverge and separate off widely from one another. These routes should be sketched on blank maps, following the instructions already given on page 376.

The Geographical Distribution of the Glaucous Gull and the Turnstone.

EXPLANATORY KEY TO FIG. 70. (MAP).

The breeding-haunts are encompassed by *dotted lines*; the southern haunts by *broken lines*.

The Turnstone, however, pursues its travels far and wide beyond these areas. The letter **T**, inserted at various points on the map, shews that the southern limits of Africa, India, Australia, New Zealand, and South America are reached. The Greenshank and Curlew-Sandpiper, which also breed in high Arctic Regions, wander to remote lands in the Southern Hemisphere.

The arrows indicate the direction of the fly-lines. Arrows passing in opposite directions indicate that fly-lines, starting from different areas, converge and overlap.

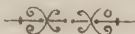
It will be observed that *the breeding-range is completely circumpolar*.

In latitude it is of considerable extent, the *dotted line* ascending to high *polar lands*, including the north of Greenland, Spitzbergen, Franz Joseph Land, and many small islands, (85° N.); and intersecting the Continents of Europe, Asia, and North America, immediately within the Arctic Circle, (70° N.)

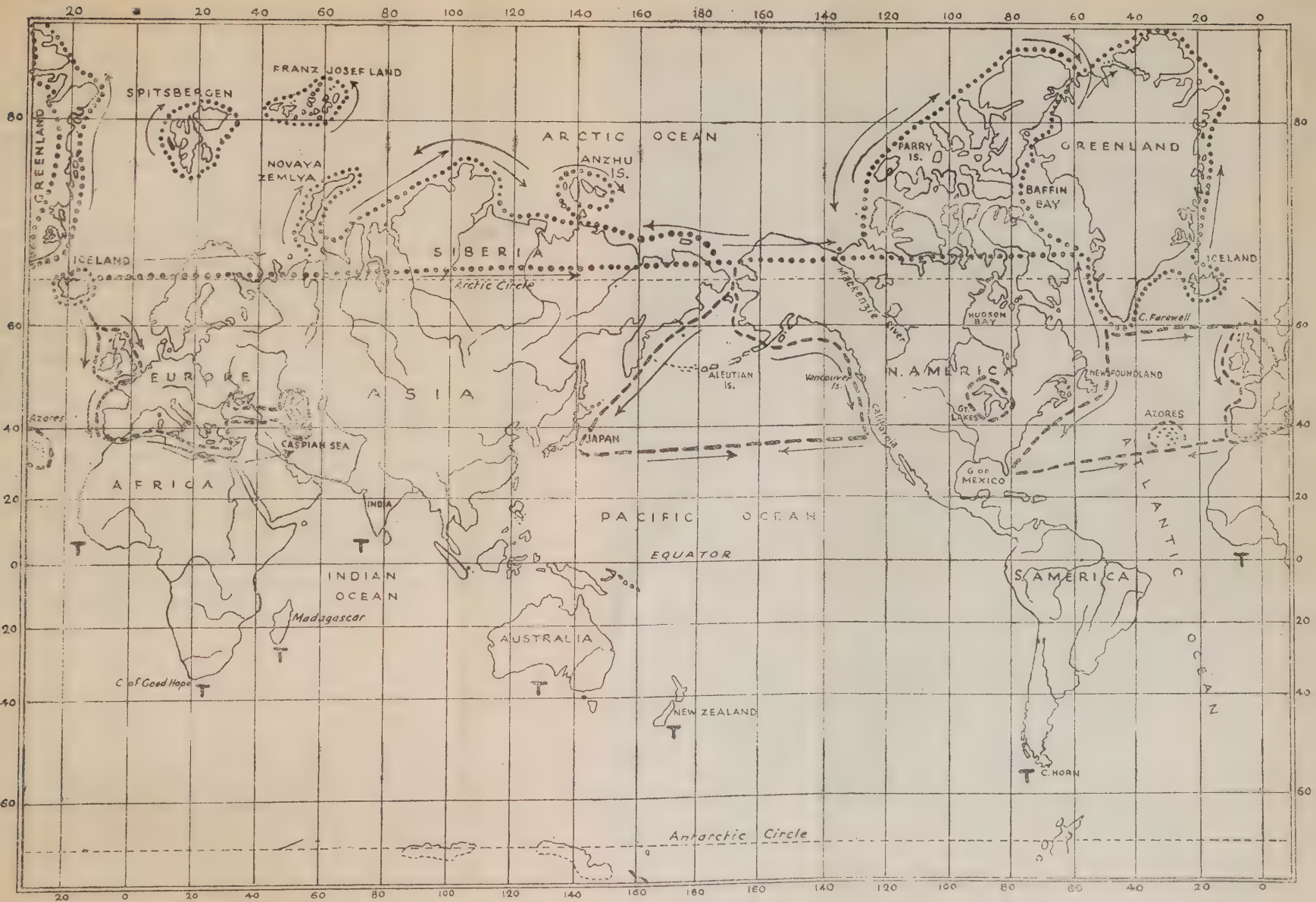
The areas which are enclosed by *broken lines* shew that the Glaucous Gull wanders southwards to the British Isles; thence down the western sea-board of Europe, and eastwards by the Mediterranean, until the Black and Caspian Seas are reached. In the Pacific Ocean this bird follows the coast-line of Asia to Japan, and of America to California.

On the Atlantic-facing sea-board of America, Texas and Florida are reached. The Great Lakes of the New World are also visited.

In winter the Glaucus Gull evidently migrates far away from its Arctic breeding-haunts, wandering along the sea-boards of the North Atlantic and North Pacific Oceans, and approaching within 20° N. Lat. of the Equator.



The Geographical Distribution of the Glaucous Gull and the Turnstone.



FOR EXPLANATORY DETAILS SEE KEY ON PAGE 380.

OCEANIC BIRDS WANDER FAR AND WIDE.

At this stage of our studies a very important question arises in connection with the migratory-routes taken by the feathered travellers. Do we know whether birds ever quit the beaten tracks and venture across vast expanses of oceanic or of terrestrial Continents? In the case of some oceanic species, strong of wing, the beaten track is certainly less defined, and migrants may be observed scattering themselves far and wide over the vast watery waste.

In the case of the smaller land-birds, such migrations are, without the least doubt, exceedingly exceptional. American birds when on migration keep to the American Continent; European and some Western Asiatic birds keep to the African Continent; while the more remote Asiatic birds, i.e., whose fly-lines lie further east, keep to the Indian and Australian Continents. Nevertheless it is true that exceptional flights are at times undertaken and accomplished by birds, which it is more convenient to include in the category of *irregular migrants*.

In the next chapter we shall have some interesting things to say about these erratic wanderers, and shall indicate the manner in which it has been made possible to establish a broad and useful classification.

CHAPTER XXVIII.

THE CLASSIFICATION OF IRREGULAR MIGRANTS.

PERIODICAL INVASIONS AND PURELY ACCIDENTAL VISITS.

Main differences between Irregular but Expectant migrants and purely Accidental or Casual visitors—'Invasions'—'Irruptions'—Contrast fluctuation in numbers of Regular migrants—Sudden appearances of Pallas's Sand-Grouse at irregular intervals—Mainly an Asiatic species—Habits, nest, and eggs—General description of the form and plumage—Resembles a pigeon more than a grouse—Its erratic westward journeys—When and where first noticed in Europe—Brief summary of its 'invasions' to the British Isles—Cases of breeding in British Isles—Has never remained for the winter in British Isles—Reasons—The erratic westward drift of the Wax-wing—A cold-weather migrant from the Arctic Regions—Has touched our shores on passage north—No British nesting-records—Geographical distribution very wide—A migrant of the Old and New World—Summary of chief 'invasions'—General description—A remarkably beautiful bird—How it received its name—A friendly species, easily identified at close quarters—The wanderings of the Crossbill—An erratic nomad—Extraordinary interest attached to its 'invasions'—Long visitations—Aftermath of breeding-birds—From an 'invader' to an 'insurgent'—A remarkably wide-spread 'irruption' into Ireland—Personal observations—Stationary-residents established after this great 'irruption'—Wide-spread British 'invasion' which enrolled many 'settlers'—Minority of regular migrants to parts of Great Britain—Wales and Ireland excluded—General description of the form and plumage—A wonderful instrument for dissecting fir-cones—Costumes of red and green—A tame and sociable bird—Easily identified at close quarters—Accidental or Casual visitors—The adventures of a meadow-pipit which crossed the Irish Sea on board of a steamer—Its condition and powers of flight—Its speed on the wing—Why the bird took the trip in such an exhausted state—Hawks and

migrants—Records in journals of casual visitors from far-off lands—Far-Eastern, Southern, and Far-Western visitors—Problems regarding their erratic wanderings—Storm-driven waifs and strays—Emaciated condition—Vigorous travellers arrive in splendid bodily condition—Travelling in the wake of near relatives—Evidence to shew the manner in which casual visitors may be piloted.

IT is sometimes a little difficult to say whether we should incorporate in the category of *irregular migrants* those birds which unexpectedly turn up, often in considerable numbers, in certain years in our Isles. True, their migrations are not rhythmic, and for that reason they are irregular, but all the same, there is a certain tendency to periodicity in the movements of these fitful travellers. In some cases it might have been only a matter of three years or less which elapsed since their visits were last chronicled; in other cases ten or even twenty years. Sooner or later, however, the visits are renewed. We might deem these migrants irregular but also expectant, in the same way as certain volcanic eruptions are wont to occur from time to time, at irregular and fortunately, perchance, at long intervals. On the other hand there are birds whose visits are *purely accidental*, birds which have strayed from their normal track, either through following the wrong pilot or through being driven far away from their destination by storm or other vicissitudes. Inasmuch as the visits are highly irregular and always quite unexpected, we here apply the term *casual visitors*. The *irregular expectant migrants* (forming the class we may in the first place consider), often come in such forces that we say an 'invasion' or '*irruption*' has taken place.

IRRUPTIVE MIGRATIONS.

It must be understood that a great many of our common migrants *fluctuate* to a very considerable extent in the numbers which arrive from year to year—so much so that owing

to *apparent* paucity in numbers, it has been supposed that in some years migrations to the British Isles have been entirely omitted. But it has been discovered on closer analysis that this assumption carries no weight, and these birds claim to be enrolled in the category of *regular migrants*. In truth, the birds had been, in a great measure, overlooked. Moreover, when more than the normal number of migrants arrive (and here I am mainly considering species which are common and widely distributed over the British Isles and elsewhere on the Continent of Europe), the fluctuations are never so marked as to give rise to the idea of an 'invasion.' On the whole, fluctuations in the numbers of regular common migrants yield more often a plus than a minus quantity.

I shall now give an account of three species (although there are others), which are included in the category of irregular though expectant migrants. Their 'invasions' or 'irruptions' have been very marked. Not only have our Isles, away out to the extreme western sea-board, but also extensive areas of the European Continent, synchronously received visitations.

'IRRUPTIONS' OF PALLAS'S SAND-GROUSE.

The sudden appearance of numbers of *Pallas's Sand-Grouse* to Western Europe, including the British Isles, from time to time, but at quite irregular intervals, is, without question, one of the most interesting and amazing events in the annals of ornithology. We must bear in mind that although this bird is not a grouse in the strict sense of the word, nevertheless it adopts the habits of the members of the *family* in not usually being given to travelling far from its native soil. It is, in the main, an Asiatic species. The breeding-range extends from South-East Russia into Mongolia.

Great numbers live in Western Central Asia. Home is on the sandy desert. Here the bird builds no nest, but lays its eggs in a shallow depression which it scratches with its feet.

During the 'invasion' of 1888, it was very interesting to find in Scotland, eggs deposited in hollows on bare, hard, soil, under heather-tufts. Heather most likely was new to these feathered denizens of the sands. Usually three eggs form the clutch. The food consists chiefly of the seeds of uncultivated grasses and other weeds.

PECULIAR IN FORM AND PRETTILY DRESSED.

I am sure you would like to have some general idea of the build and the plumage of this strange bird. Well, it differs considerably from a grouse in that it does not carry itself with an upright,—we might say assertive—carriage. Indeed, as it walks along, its breast almost touches the ground, owing to its extremely short feet and legs. It has a crouching gait, and a curious habit of almost burying itself from time to time in the sand, thereby rendering its presence very inconspicuous, especially so because its plumage harmonises quite closely with its surroundings.

In outward appearance and in habits generally, it reminds one more strongly of a pigeon than a grouse. But note, it possesses the more robust beak of the game-birds. In that respect it differs very markedly from a pigeon, in which the basal part of the beak is soft, and the nostrils are uncovered by feathers. But like a grouse, its feet and toes are thickly coated with fine hair-like feathers. The hind-toe is absent, and its wings, unlike those of the grouse, are very long and pointed, as are also its central tail-feathers. (Fig. 71.)

It is a nicely-marked bird, the adult male having a yellowish-grey head, a whitish chin, and a pale rusty-shaded throat. Its upper plumage shades into rich buff, strongly barred with black. Its outer flight-feathers and elongated central tail-feathers are bluish-grey. Its neck and breast are



FIG. 71.—PALLAS'S SAND-GROUSE.

"It has a crouching gait, and a curious habit of almost burying itself from time to time in the sand...it reminds one more strongly of a pigeon than a grouse....But like a grouse, its feet and toes are thickly coated with fine hair-like feathers...its wings, unlike those of the grouse, are very long and pointed."

greyish-buff, interrupted by a mottled black throat-gorget. Its lower breast is banded with black, and the feathers under the tail are, like its hairy feet and toes, dull cream in colour. The head of the female is striped and spotted with black, and the general shade of her dress is duller than that

of her mate. Moreover, her central tail-feathers are shorter. Such is a brief description of Pallas's sand-grouse. (Fig. 71.)

A word next about its erratic migrations. From its Asiatic home it has in a most sudden, spasmodic manner, at irregular periods, moved westward, often in immense numbers. This migratory wave has spread far and wide: west to Spain, France, Great Britain and Ireland; south to Italy; north to Norway and Archangel.

HISTORY OF 'IRRUPTIONS' OF PALLAS'S SAND-GROUSE.

The bird was first noticed in Europe in 1848, near Sarepta in South Russia; in Western Europe it was first noticed in 1859. Here is a brief summary of the 'invasions' or 'irruptions' to the British Isles, the birds appearing in other areas of the European Continent synchronously. In May, 1863, large numbers appeared, but in 1888 the 'invasion' was on a grander scale. The birds poured in along the entire east coast of Great Britain, and spread themselves over the greater part of the British Isles, reaching the rugged Atlantic-facing sea-boards of Ireland and the Hebrides. Eggs were found near Beverley in Yorkshire in June and July, and young birds were discovered on the Cubin sands, Elgin, in June and in August of the following year. Another big 'irruption' took place in May, 1908. Smaller 'invasions' occurred in the years 1859, 1872, 1876, 1890, 1891, 1899, 1904, 1906, and 1909.

Observe that Pallas's sand-grouse, notwithstanding its numerous visitations, and the fact that it found its quarters comfortable enough to breed on some occasions, has never taken up its residence in our Isles. The reason, after all, is not far to seek: a desert-loving species, basking for most of the season in the full glow of sunshine, could hardly adapt

itself in the colder months to the moisture and gloom of our climate, and I doubt if the physical features of the British Isles, with their monopoly of crag, moor, swamp, and beach, could afford adequate nesting-sites for more than a small number of birds. Remember that the 'invaders' in Scotland alone, in 1888, were estimated at least 2,000 strong!

'IRRUPTIONS' OF WAXWINGS.

In contrast to the strange wanderings of Pallas's sand-grouse from its sunny, Asiatic home in the desert, let us now turn our attention to those of the *Waxwing*.

This bird, a native of the Arctic Regions, is strikingly beautiful. As might be expected, its irregular visits take place in the cold weather. In other words it occurs as an *irregular winter-visitor*. In spring, when journeying northwards to its home, it has touched our Isles on passage, but there are no records that it has ever tarried to breed. In this respect it differs from Pallas's sand-grouse which, despite its more puzzling migrations, has managed to establish its nativity in a few instances on British soil! It is much easier to explain how the migrations of the waxwing to the British Isles at irregular intervals have taken place. The appearances of numbers in certain winters, represent the overflow of the westerly fringe of an exceptionally large wave of migration. More usually the European fly-lines lie to the east of our Isles. Severe Continental weather is very likely an important factor in deflecting the wave westward. The breeding-range is extensive, if not altogether Circumpolar. In winter the migrations extend to Temperate Regions of the European, Asiatic, and American Continents.

RECORDS OF 'INVASIONS' OF THE WAXWING.

The record of the first 'invasion' dates a long way back, nearly two-and-a-half centuries, namely, 1686. Subsequently the winters of 1834-5, 1849-50, 1866-7, 1872-3, 1892-3, 1903-4, 1913-14, and lastly, only a few years ago, namely, of 1924-5, were noted for the large numbers which reached the British Isles. The 1903-4 'invasion' was well-marked also in Ireland. The brunt of a waxwing 'invasion' usually occurs along the eastern side of Great Britain—the birds thin out on the opposite coast; while Ireland, lying further to the west, catches occasionally a mere fringe of the migration-wave.

Quite obviously we cannot apply the term 'invasion' or 'irruption' with the same force in the case of the migrations of the waxwing as we can in the case of the migrations of Pallas's sand-grouse. The former represent only an extension to the west of a regular rhythmic movement to and from Arctic and Temperate Europe. The birds which reach the British Isles are as ripples deflected from the main wave. There is nothing corresponding to the spasmodic migratory movements of Pallas's sand-grouse, which are as yet unexplained. In the latter case, the birds set out most unexpectedly, and, detaching themselves from the rest, push westward, forming special companies or battalions. No better term than 'irruption' could be applied to these spasmodic migratory movements; no better term than 'invader' could be applied to the migrants themselves when they pour into our Isles!

Lastly, I wish to lay stress on the fact that while it is expedient to include the waxwing in the category of irregular but expectant migrants, it is not at all unlikely that at least a few individuals drift to our Isles *annually*, but their visits are not always recorded. However, as the unexpected arrivals of large numbers at quite irregular intervals are quite well-

marked, it is more advisable to classify this bird as an irregular but expectant migrant to the British Isles.

Now, my young friends, I do hope that you will have the opportunity of observing the waxwing for yourselves some day



FIG. 72.—WAXWING.

"Our welcomed visitor wears an elegant dress. Part of his face is black, which matches his 'neck-tie.' He has a long, but thick and tapering crest of chestnut-brown....a jine fellow, not only in his dress but also in his bearing, and...he is so friendly that when feeding on berries, he will allow us to come close up. His identification in this way is made certain."

soon. Perhaps you became acquainted with it in the winter of 1924-5, when large numbers visited Sheffield, and other districts. It is well worth while inspecting a skin or mounted specimen in the museum, and noting the unique manner in

which some of the wing-feathers are tipped with red 'sealing-wax': Hence the appropriate name '*Waxwing*.' (Fig. 72.)

THE PLUMAGE OF THE WAXWING.

Altogether our welcomed visitor wears an elegant dress. Part of his face is black, which matches his 'neck-tie.' He has a long, but thick and tapering crest of chestnut-brown, somewhat darker and richer in tone than the rest of his plumage, exclusive of the wings, which are for the most part black with a white wing-bar and white tips to several of the feathers, some of which exhibit the very brilliant-red waxy points already mentioned. The dark brownish tail-feathers are also banded with yellowish white. Yes; Mr. Waxwing is a fine fellow, not only in his dress but also in his bearing, and remember he is so friendly that when feeding on berries, he will allow us to come close up. His identification in this way is made certain. (Fig. 72.)

'IRRUPTIONS' OF CROSSBILLS.

From the wanderings of the waxwing we pass on to consider very briefly the wanderings of the *Crossbill*.

Here we have to deal with a bird which is decidedly nomadic or prone to move off periodically, but at irregular intervals; then great numbers may arrive in our Isles. The birds are wont to appear early in June, a month when the tide of migration, in the case of regular and rhythmic movements, has reached its lowest ebb. These mid-summer visitors are frequently immature; there is reason to believe that they represent birds of early broods, for, oddly enough, crossbills breed during January, February and March. But on the other hand, strange to say, egg-laying takes place again in June and July. The late broods most likely represent descendants

of our resident birds, that is to say, birds which have settled down in the country, and finding very suitable *habitat* amidst the fir-cones, have established themselves with their families.

There is something extraordinarily interesting about the sudden 'invasions' or 'irruptions' of crossbills to our Isles. Invaders they are without a doubt, far more so than the two previous species which have been considered.

When foreign crossbills (in other words those from the European Continent) arrive in mid-summer or later in the season, in what way do they behave?

They systematically spread themselves widely over the country until they discover large, fertile, pine-plantations. There they settle and, if food be plentiful and enemies scarce, they seem in no hurry to move off. They are tame birds, confiding in the presence of man, and indeed of many other creatures excepting their deadly enemy, the Sparrow-Hawk, which they are ever ready to evade with singular alertness.

These visitors, or at any rate a large proportion of them, remain for ten or twelve months, breeding in the meantime. An 'invasion' therefore leaves a considerable aftermath of breeding-birds. Hence the crossbill oversteps the rank of a mere 'invader' and becomes an '*insurgent*.'

Several instances of 'insurgents' becoming '*settlers*' in both Great Britain and Ireland after an 'irruption,' are well authenticated.

REMARKABLE 'IRRUPTIONS' OF CROSSBILLS INTO IRELAND.

The years 1887-8 proved memorable in the annals of ornithology for a widespread 'irruption' of crossbills into Ireland. I can vividly project a picture of the numbers of times on which I observed crossbills, some in small parties, others in flocks.

I was certainly struck by and immensely pleased at the tameness of the birds. As they vigorously attacked the conifer-seeds (and occasionally broke into orchards and attacked apples for their pips), they reminded me not a little in their deportment of small parrots.

Many years afterwards, when I was watching wild parrots in Australia, I was reminded of pleasant days spent in watching the crossbills in Ireland.

One day whilst conversing with a friend, a small flock of crossbills flew overhead in descending flight. An unfortunate bird struck a telegraph-wire and fell dead at my feet : its companions had a narrow escape ; indeed I think a few others collided with the wires but managed to keep on the wing, at least until they had passed overhead. Though crossbills had bred in Ireland (after an 'irruption') fifty years previously, nevertheless they did not establish themselves so firmly or spread themselves so widely until after the great 'invasion' of 1887-8. Since, they have become residents in Ireland in no mean numbers, chiefly in conifer plantations.

RECORDS OF 'INVASIONS' OF CROSSBILLS.

The records of this species breeding in Great Britain also go back fifty years previous to the great Irish 'invasion.'

It would appear that in 1838-9 a wide-spread migration occurred over the British Isles, following which many settlers were enrolled. The details of subsequent 'irruptions' up to the present time would be too numerous to mention ; suffice it to say that, on an average, every three to a dozen years crossbills turn up in great companies in our Isles. It is interesting to learn that this very year an 'irruption' on a grand scale occurred over the British Isles, and spread itself to the western shores of Ireland.

We must recollect, before going further, that in some districts of Great Britain the crossbill *is a regular migrant*, arriving at variable times in the year, but most often in late summer, and then sojourning for a variable period. When the breeding-season comes round, however, these visitors return to their Continental homes. Quite possibly a small proportion may remain to breed; but settlers, as we have seen, as a rule only enroll themselves after an 'invasion' has taken place. Generally speaking, in Great Britain, including the whole of Wales, the crossbill is an irregular migrant, and I doubt if it has migrated to Ireland apart from 'invasions.' On the other hand we have evidence that this wanderer is also a dominant station²-resident in Ireland, and is distributed in each of the four provinces. Similar evidence seems less definite respecting Great Britain, where, although breeding takes place in fair numbers over a wide area, albeit, the bird definitely appears to be much more migratory; indeed regularly so in some districts.

To sum up; we would say that in regard to some areas of *Great Britain, the crossbill might be included in the category of both regular and irregular migrants: in Wales of an irregular migrant; in Ireland of an irregular migrant and of a stationary resident.* In any case its uneventful annual, (that is regular migrations), are so far eclipsed by its remarkable 'invasions' during some years, that emphasis must be laid upon the fact that the *crossbill is mainly an irregular though an expectant migrant to the British Isles.*

CONTRAST COSTUMES AND A CURIOUS BEAK.

Now, let me say, that apart from the study of its migrations, the crossbill is a very interesting bird. I hope that you have seen *him*—and here I am obliged also to say *her*—

A Nomadic Invader.



A.—CROSSBILL.

"The crossing of the points of the beak is very curious...it might be regarded as a deformity. The lower mandible possesses strong side-movement, and when the mouth is opened it can rapidly dislodge the seeds of fir-cones. The tongue in an instant is then shot out and it scoops the food into the mouth."



HEADS OF CROSSBILLS.

(Photos by the Author.)

"The males are robed in red...the females in green....The young of both sexes are greyish....In dress they are alike: their parents....are very unlike."

B.—Right profile.

Observe, the under segment of the beak crosses to the right of the upper segment.

C.—Left Profile.

Observe, the under segment of the beak crosses to the left of the upper segment.

for the two sexes differ markedly in plumage. If you have not seen the bird alive, look at a stuffed specimen in the first instance.

The crossing of the points of the beak is very curious, indeed unique ; at first sight it might be regarded as a deformity. The lower mandible possesses strong side-movement, and when the mouth is opened it can rapidly dislodge the seeds of fir-cones. The tongue in an instant is then shot out and it scoops the food into the mouth. (PL. XXVIII. B.C.)

Owing to the tameness of the crossbill, its plumage can be studied at close quarters ; moreover owing to its highly sociable disposition, we are generally favoured with an opportunity of examining the dress of adults and immature birds.

" Let's pretend " that we are studiously watching some twenty crossbills busily operating upon the fir-cones. The sun is shining so brilliantly that some of its beams penetrate the glade and play upon the foliage and its feathered occupants. Aided by good illumination we observe that some of the birds are mainly dull blood-red in colour ; the shade brightening up over the root of the tail ; the wing and tail-feathers themselves, however, are brown ; this is the distinguishing dress of the adult males, nevertheless smaller numbers have their ruddy plumage interspersed with gold. We also see greenish birds tinged with orange, and in some the green merges into gold in which a few reddish patches are interspersed. The green to golden ground-colour is the distinguishing dress of the adult females.

Here then is a striking contrast in the dress of the two sexes. The males are robed in red and shew but a sign of green : the females in green in which the red is almost totally eclipsed. The young of both sexes are greyish, with a mere suggestion of green ; their under plumage is distinctly

streaked. In dress they are alike: their parents, we have seen, are very unlike. (PL. XXVIII. A.B.C.)

A MEADOW-PIPIT'S ADVENTURE AT SEA.

Our next business is to try and learn all we can regarding the migrations of those birds whose visits are purely accidental: birds which may aptly be called *Casual Visitors*.

By way of illustration I shall, in the first instance, give an account of a migratory movement of a solitary little bird which I had a favourable opportunity of witnessing quite recently, indeed only since I wrote the last chapter.

I was crossing the Irish Sea by steamer from Kingstown—now called Dun Laoghaire—to Holyhead, when from the deck I descried a meadow-pipit flying alongside, just clear of the waves.

I saw distinctly that the little traveller was fatigued; indeed it could keep up only with difficulty with the speed of the boat. I think that the bird felt aware of the danger which the presence of the herring-gulls threatened. Because when these birds closed up astern of the boat, the pipit came on board. It at once sought shelter, and endeavoured to evade observation by crouching among ropes and other gear. Luckily nobody else became aware of its presence; nor did I tell anyone for fear of its being disturbed from its place of concealment. I was most anxious that the traveller should obtain a safe passage to Holyhead. I felt firmly convinced that if the bird took to the wing once again, it would, when flitting laboriously over the waves, be instantly engulfed by a herring-gull. Such a tragedy is quite common; I have more than once been a witness.

Observe, this little bird was, strictly speaking, undertaking only a very short *inter-British migration*, but the movement in its particular case was certainly *highly irregular*,

not only seasonally, but also because a tired bird was making a pronouncedly laboured endeavour to travel, against its will ; owing no doubt to some untoward misadventure.

The normal speed at which a meadow-pipit migrates (for very much longer distances than across the Irish Sea) is about thirty-five miles an hour. In this case the bird was finding it difficult to travel at the speed of twenty-two miles an hour, because it could only with difficulty manage to keep alongside the steamer.

THE MEADOW-PIBIT EXHAUSTED.

Why then did this pipit, in such an exhausted condition, undertake the responsibility of the trip ? The spring migrations had quite come to a close, in fact one very seldom meets with a land-migrant at sea towards the end of the month of June. Adverse weather had nothing to say to the case ; the morning was perfectly calm, warm, and sunny. I have known instances where little birds have been blown out to sea by an off-shore gale. Possibly the poor wee mite was being hotly pursued over the beach by a hawk, and was able to effect an escape by the one and only method to hand, namely, by putting out to sea. Little birds sometimes get away by so doing : for hawks do not always like to sustain the chase over the sea when they run into a company of gulls and other hostile marine birds. I have seen more than once, groups of feathered spectators giving chase to the plunderer. Well at any rate, whatever happened, the little pipit embarked on its sea-trip in rather an exhausted condition, and no doubt on reaching the pier at Holyhead—which I am glad to say it did safely—it remained resting quietly for some time, but being a common bird no one noticed it. Indeed the circumstances of this irregular migration would never have

come to light but for the fact that I detected the bird's whereabouts.

I have related this remarkably interesting story because you will see later on that it offers a suitable object-lesson, indeed an actual illustration *from life*, in regard to what I wish to dwell upon when we study the fortuitous wanderings of *casual visitors* to our Isles.

PROBLEMS REGARDING CASUAL VISITORS.

If we were to look up a journal specially devoted to birds, we would find that every year not only water-birds, but also land-birds, reach our Isles when on migration to other lands afar off. Far-Eastern migrants stray across the vast tracts of the great Continents of Europe and Asia; Southern species, destined only to reach the shores of the countries fringing the Mediterranean Basin, overshoot the mark and continue their travels to our latitudes. Lastly, birds from the New World manage to cross the Atlantic, perhaps by assisted passages on ships; perhaps by migrating first to Greenland, thence by way of Iceland, the Faroes, Shetlands, and Orkneys, to the Scottish coast-lines. Small land-birds could hardly cross the Atlantic by an open non-stop passage, even if they rested at the Azores, the Bermudas, Cape Verde Islands, or other stations *en route*.

I am not by any means so sceptical about wading-birds being capable of performing a non-stop Trans-Atlantic trip. I shall touch upon that point in some detail later on. In the meantime we can close to-day's chapter by noting that many of these casual migrants arrive in a very poor, often half-starved condition: it may be surmised therefore that such birds are driven out of their course by adverse circumstances, often being held up by gale or fog, and then in

pursuing their journey they lose their bearings and finally become stranded in localities foreign to their customary destination. On the other hand, casual migrants, rare to our Isles, have arrived in a very vigorous condition. These possibly may have been piloted by other birds to which they are related, such being common and widely distributed British migrants. The evidence shewing the manner in which these birds are piloted will be set forth in the next chapter. We shall also have much to learn in regard to the advent of birds at the lighthouse, their behaviour and fate. Truly an entrancing story, full of thrilling experiences.

LECTURE 18.

CHAPTER XXIX.

BIRDS AND THE LIGHTHOUSE.

CASUAL VISITORS FROM THE OLD WORLD.

Resident on a remote light-station for several consecutive weeks—Description of a light-station—Tower—Balcony—Lantern—Dwelling-houses—Why an island-rock makes the best light-station for a bird-observatory—The most suitable form—A survey for dead and living birds—Why birds strike the lantern—A huge decoy—The sojourn of fatigued birds on the rock—The search for dead and wounded birds—Thrilling experiences on the balcony on a migration-night—Intense brilliancy of the rays—Effacement of plumage-patterns—Gigantic scintillating 'precious gems'—Decorated with birds—Perching-purposes—Swarms of migrants round the lantern—Hundreds killed but thousands escape—Casual-visitors which appeared at Irish light-stations—Rare and most valuable treasures—Story of a Siberian Skylark—Far-Eastern migrant—A vigorous migrant, very fat, and in good condition—Common skylarks as pilots—Story of an Aquatic Warbler—South-Eastern migrant mainly—Also a vigorous migrant, fat, and in excellent condition—Sedge-warblers as pilots—Sedge-warbler an abundant summer-resident—How to distinguish the aquatic warbler from the sedge-warbler—Story of a Black-Eared Wheatear—A great prize—First obtained in Ireland—South European species—Inhabits countries fringing Mediterranean Sea and North African Continent—Limited fly-lines within the confines of these latitudes—Overshot the mark—Another vigorous migrant in excellent condition—Piloted by a company of common wheatears—Three strangers met their fate by striking themselves forcibly against the lantern—The pathetic story of an Icterine Warbler—Wide European distribution, east of British Isles—A poor emaciated little waif—

Separated from its companions—Picked up dead on the rock in daylight—Sojourned and died from exhaustion—No pilot, drifted aimlessly about on the wing—Driven from usual migration-route by stress of weather—Short description of the form and plumage of these rare valuable Old World casual-visitors—Discovery of Tree-Pipit in Ireland—The long expected visit authenticated—Bird probably often overlooked.

IT was when resident at light-stations—very lonely and remote spots off the Irish coast—that I had the good fortune to make several fascinating, as well as valuable discoveries. I have indeed some thrilling experiences to relate, my young friends, in regard to *casual*, otherwise known as *accidental migrants*. It is well to know at the outset that in addition to the lighthouse itself (that is to say the tower), the station is equipped with dwelling-houses for the keepers. There are also out-houses for oil, ropes, and other gear, too diversified to mention. Hiding-places, therefore, for feathered waifs and strays are not wanting. Some light-stations are built on the mainland. In the study of migration they present drawbacks, because the birds, on arriving, can pass inland without delay or difficulty, and in that way they soon become lost to view amidst trees and other cover. The best station at which to reside, is one that is situated on a small rock, completely surrounded by water, hence forming an island.

Picture an island-rock no bigger, say, than a football field! The flatter and smoother the rock the better, because we can ramble all over it, examine every nook and cranny, and also descend to the water's edge. Following such a complete survey, very few birds should escape notice, dead or living.

A HUGE DECOY.

Why dead or living? Let me explain: hosts of birds migrate at night, and large numbers, becoming dazzled by the

intensely brilliant beams of the lantern, strike the glass, some so violently that they kill themselves outright.

.....“ The beacon’s blaze allures
The bird of passage, till he madly strikes
Against it, and beats out his weary life.”

Others fly round the lantern until, growing thoroughly tired, they descend to the rock; here they may, and often do, remain for some days, especially in stormy weather. If, after a vast nocturnal migration, we carry out a diligent search at daybreak over the entire station, we are sure to discover numbers of birds, some dead, others alive but usually very fatigued.

A THRILLING EXPERIENCE.

Before telling you about those rare and valuable treasures, the *casual visitors* above indicated, let me recall one out of many of my thrilling experiences which took place at the *lighthouse balcony* during a tremendous migration of all sorts of birds.

The spectacle was weirdly attractive and novel as the bewildered migrants began to reel and topple under the influence of the blinding luminous beams of light. The intensity of the rays of the lantern not only blotted out the pattern of the plumages, but birds, whether dark or fair-plumed, appeared white or red according to the colour of the ray in which they flew, while the fluttering of their wings gave me the idea that hundreds of gigantic sparkling or scintillating precious gems were careering madly round the lantern.

More wonderful and novel still became the spectacle, as I stood on the dizzy heights of the balcony on that migration-night amid an assemblage of myriads of migrants, and found my own person being made use of for perching-purposes, and to so great an extent that I was actually decorated with birds !

I can vividly bring back to mind that pitchy dark, calm, mild, misty, night, when the rays of the lantern were unusually brilliant.

DECORATED WITH BIRDS.

How well I remember a little willow-warbler alighting on the top edge of my ear ! Several swallows sat on my right shoulder quite contentedly and in a line (as they may be observed to do on telegraph-wires) ; on my left shoulder two thrushes and a blackbird jostled each other for perching-space : a goldcrest, tiniest of all European birds, alighted on the button of my coat ; and finally a starling, in a frantically frightened state, sought shelter by scrambling up my leg and then clinging to the rim of my waistcoat-pocket !

On that memorable night, hundreds of birds, dazzled beyond measure and powerless to stay their flight, dashed headlong against the lantern, and were killed outright.

But it is cheerful to remember that if the losses appeared heavy, they were as ' a drop in the ocean,' so vast were the numbers of night-flying migrants which passed the danger-zone unhurt.

No doubt you are anxiously waiting to hear what I have to relate about the *casual visitors*. Well, I shall tell the story of some which furnish the most interesting records. These rare visitors all turned up at light-stations off the Irish coast ; for that reason I have presented to the National Museum, in Dublin, those which have been collected. As Irish specimens they rank very rare, and therefore are valuable.

A SIBERIAN SKYLARK.

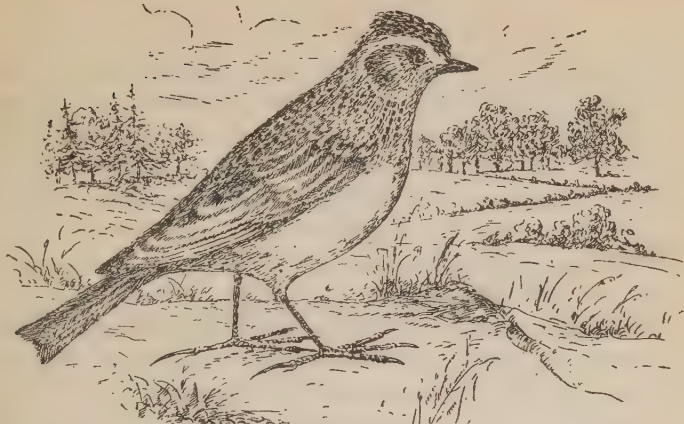
I shall lead off by describing the manner in which I obtained a Far-Eastern migrant, namely, a *Siberian Skylark*.

One night in October, thousands of skylarks appeared round the lantern. Numbers were killed by striking the glass. It happened that, owing to rough weather, our relief-boat was delayed, and became so overdue that we found the dead larks very acceptable for food ! This led us to organise an extra special search ; so we hunted for dead birds, not only in nooks and crannies on the rock, but also on the roofs of the dwelling-houses, and in the gear-rooms and in other places of accommodation. In gathering a basketful, chiefly of larks, but also of numbers of blackbirds and thrushes, I picked off the roof of a dwelling-house, a specimen, which no doubt from its form and the general pattern of its plumage was a lark, but I noted that it was smaller, and had a shorter and more slender beak than the ordinary skylark. In pattern, the plumage was almost similar, but instead of exhibiting a rich buff ground-colour with darker streaks, the ground-colour of this strange bird was ashy-grey with dark streaks. Moreover the under parts were pure white, devoid of the yellowish tinge present in the same parts of the ordinary skylark. The eye-stripe was also whiter and better defined.

I was thrilled when the bird turned out to be a *Siberian Skylark*—a species quite new to Ireland. (Fig. 73, A.)

This specimen was obtained in the autumn, and therefore was outward-bound from its breeding-home in Western Siberia. Normally it would have flown southwards by way of the Asiatic Continent in order to sojourn during winter in Persia, Turkestan, Egypt, or other warm country of the East, or in some part of Africa as far west as Algeria.

Did the bird stray away by itself and take an immense overland route across the Continents of Asia and Europe ? No ; it most likely bore westward by a coastal route from its Siberian home before directing its course southwards.



A.—SIBERIAN SKYLARK.



B.—COMMON SKYLARK.

FIG. 73.—DISCOVERY OF THE SIBERIAN SKYLARK IN IRELAND.

"I picked off the roof of a dwelling-house, a specimen, which...was a lark, but....it was smaller, and had a shorter and more slender beak than the ordinary skylark....I was thrilled when the bird turned out to be a Siberian Skylark—a species quite new to Ireland....It seems likely...that this wanderer was piloted to the Irish coast by many hundreds of our skylarks."

A VIGOROUS MIGRANT PILOTED.

Reaching Northern Russia and Scandinavia, it would likely fall in with thousands of our skylarks, all outward-bound on their southerly migration for the British Isles as well as for Continental Europe, some proceeding further onwards to South Europe and North Africa. It seems likely therefore that this wanderer was piloted to the Irish coast by many hundreds of our skylarks, scores of which also came to a tragic end at an Irish light-station.

This Siberian Skylark was in excellent condition ; indeed, like other vigorous migrants, it was remarkably fat. Its plumage was perfect and its gizzard was quite empty. These facts indicate that a regular and rapid journey had been accomplished, the traveller not tarrying on the way to take food. The bird therefore cannot in any sense be regarded as a waif or stray which had been driven out of its course by storm or fog. It was immature and inexperienced, and embarking on its southerly journey, deviated far to the west of its normal fly-line. With the exception of only one other of its kind, obtained in Ireland a year previously (but not identified until a year after mine was obtained), and another collected four years previously at the Flannan Islands Light-house, Scotland, no other specimen had been recorded up to that time from Europe, except in the Far East. These three examples, therefore, must be looked upon as *very rare casual visitors* to the British Isles and as highly-treasured museum specimens.

AN AQUATIC WARBLER.

The next bird which I shall speak about is the *Aquatic Warbler*, a little fellow, smaller than a robin and lightly built.

One night, in the beginning of August, large numbers of sedge-warblers, and other common migratory birds (which

at that early season had already commenced to migrate southwards from their breeding-grounds), struck the lantern. Sure enough, among large numbers of birds gathered up, I discovered a great prize, yes; *an Aquatic Warbler, the second hitherto recorded from Ireland!* The bird was immature, in splendid condition, and very fat. Its plumage was perfect and its gizzard was quite empty.

It is intensely interesting to learn that the fly-lines of the aquatic warbler lie to the east of the British Isles, also, in a large measure, that they hardly reach as high north as our latitudes. True, some of the travellers wend their way as far north as Denmark, but the main breeding-haunts on the western section of the Continent of Europe are situated to the south-east of our Isles. Eastward the bird ascends higher and becomes well distributed in Germany, being actually numerous in some districts of Poland. *North Africa* marks the southerly limits of distribution, and *there* most of the migrants spend their winter; others are resident all the year round. Speaking generally, the fly-lines of this little warbler are not extensive, the to-and-fro movements being made between the Mediterranean Basin and Central Europe.

ANOTHER VIGOROUS MIGRANT PILOTED.

Here then again we have a migrant which, on its outward-bound journey for southerly quarters, wandered westward until it reached the Irish sea-board. Whether it crossed the North Sea directly from Denmark (that is to say took a due westerly course in our latitudes before going south), or through mischance steered north from a more southerly latitude of Continental Europe (in all likelihood from the coast of France), before proceeding south, it is of course impossible to say.

However we can stipulate safely that this casual visitor was not a solitary, storm-driven waif ; on the other hand, it was a vigorous migrant which made a rapid journey and arrived in a vigorous condition on the coast of Ireland.

No doubt it joined company with hundreds of common British migrants, including its near relative the sedge-warbler, all of which, when travelling south, pass along the British and Irish sea-boards.

THE FAMILIAR SEDGE-WARBLER.

Before describing the Aquatic Warbler, it may be well to direct our attention for a moment to the Sedge-Warbler, a near relative, which it closely resembles. Very likely some of you have come across the sedge-warbler in your rambles. Marshy spots, especially among osier beds, are the chief haunts, but we are never surprised to detect and hear the sedge-warbler as it makes its way along the bottom of hedgerows, briars, and other tangled vegetation. It is, on the whole, common and widely distributed in the British Isles. But remember, it is a summer-resident and, like the swallow, leaves us in autumn for warmer climes. Thousands pour into Great Britain every spring, and the bird is common also in Ireland. Most warblers are sombre-plumed, the sedge-warbler being no exception to this general rule. Its upper plumage is warm brown with darker streaks, the lower back and upper tail-region being more tawny in shade. The chin and throat are nearly white, the breast and the rest of the under parts, pale buff. The only conspicuous marking in this little bird is the well-defined broad *whitish* streak over the eye, which stands out against the darker feathers of the crown of the head. Its song is bright and joyous, but full of harsh notes, and is heard often at night.

In Ireland the sedge-warbler is sometimes called the *Irish nightingale*. He is a loquacious little bird, and can imitate the notes of many species. He is more often heard than seen, because he is prone to skulk low down amid the sedges.



FIG 74.—DISCOVERY OF SECOND AQUATIC WARBLER IN IRELAND.

A.—AQUATIC WARBLER.

"If he be more shy, he is none the less loquacious; indeed he is quite fond of uttering his scolding note of alarm, a croaking sound, like that of the sedge-warbler."

B.—SEdge-WARBLER.

"He is a loquacious little bird, and can imitate the notes of many species. He is more often heard than seen, because he is prone to skulk low down amid the sedges."

The reed-bunting perches sedately on the tops of the sedges: the sedge-warbler in ambush sings below: the reed-bunting often is credited with the song, which is much better than his own! Study these points in the spring for yourselves, my young friends; they are full of interest. (Fig. 74, B.)

PLUMAGE OF THE AQUATIC WARBLER.

The aquatic warbler, though just a shade smaller, closely resembles in form, deportment, manners, and song, his cousin the sedge-warbler. If he be more shy, he is none the less loquacious; indeed he is quite fond of uttering his scolding note of alarm, a croaking sound, like that of the sedge-warbler. There are, however, plumage-markings which stand out *boldly*, and therefore make identification at close quarters quite easy. The broad buffish-white streak which runs along the middle of the crown of the head, from the base of the beak to the nape of the neck, is an unfailing mark of identification. The head of the sedge-warbler shews only narrow pencilled buff-coloured lines, though these are subject to variation, and in some birds are very distinct.

Then again, the upper parts of the plumage are *boldly* streaked with brown and buff. In the sedge-warbler's dress there are no such light and dark contrast markings. In the aquatic warbler the under parts are pale yellowish-buff, streaked with brown on the flanks. The whitish eye-stripe is quite as conspicuous as that of the sedge-warbler. (Fig. 74. A.)

Bearing all these points in mind, there would be no difficulty whatsoever in distinguishing the two species at close quarters. (Fig. 74. A.B.)

Take a look at specimens in the museum !

A WESTERN BLACK-EARED WHEATEAR.

The next casual visitor, in regard to which I shall say a few words, proved to be a *great prize*;—*the first ever obtained in Ireland*. The bird is known by the name of the *Western Black-Eared Wheatear*. It is essentially a species which usually is found at any season far south of our latitudes. It inhabits

those countries which fringe the western area of the Mediterranean Sea ; also the African Continent, passing through the western section of the Sahara Desert, and as far south as Senegambia. It apparently migrates within the confines of these latitudes ; but very probably many individuals are residents. This splendid Irish treasure was obtained in spring, in the month of May ; in all likelihood it was a migratory individual which had set out to seek its breeding-haunts. Normally, the route should have entailed a comparatively short journey in a northward direction, namely, from countries adjacent to the Mediterranean Sea to countries south of the Alpine-range and south Tyrol.

Surely then, it is obvious that our *rara avis* travelled exceptionally far northward ; in other words he overshot the mark and exceeded the bounds of his normal geographical distribution to a very considerable extent.

A THIRD VIGOROUS MIGRANT PILOTED.

Can we offer any reasonable explanation for his extended travels ? I think we can. Note carefully that many common wheatears were moving northwards at the same time. On migration these birds are exceedingly abundant all along the western sea-board of Europe and thence along the whole of the Br'tish and Irish coasts. Although this strange wheatear travelled much beyond his usual range, he did not grow fatigued, for he arrived at the light-station in perfect condition. His gizzard was empty, hence he did not tarry to look for food *en route*. He was not buffeted by storm nor delayed by fog.

He was brimming over with energy—as vigorous migrants all are in spring—and finding himself in the company of many common wheatears and other migrants, he was borne

along to the Irish coast, and with many of his companions he shared the same fate by striking the lantern of an Irish light-station. (Fig. 75.)

FIELD-CHARACTERS AND PLUMAGE OF THE WHEATEAR.

No doubt you would be interested in a brief description of this extremely rare and beautiful casual visitor.

First of all what are the field-characters and plumage-markings of our common wheatear? I dare say that many of you know this sprightly little gentleman! He is widely distributed as a summer-resident in our Isles, frequenting mainly uncultivated districts, especially when not far from the coast. We find him on both rocky and sandy beaches, on cliffs and hill-sides, on sand-dunes, and, away from the sea, on waste uplands, and more sparingly on heath-clad moors and crags. Small numbers may be observed in summer on the moors of Sheffield.

The wheatear loves the open country and has no interest in cultivated lawns, plantations, or public parks, thronged with human traffic. In form and movements we cannot mistake this species. He is just a shade larger than a robin, and, like the latter, often stands high on the ground. However he is longer and more slender in build, and his tail is shorter and very noticeable, being milky-white, broadly banded with black. The white is carried up to the lower region of the back. When the bird lifts and fans his tail by a series of jerks, the white is very conspicuous and shews up in marked contrast to the black wings. In flight these parts of the plumage are still more noticeable. In the male the rest of the upper plumage is delicate french-grey; in the female, tawny-brown. The male has a bold, black patch on the cheeks, brown in the female; under parts white, much tinged

with buff in the female. Therefore such well-defined contrast colours as french-grey, black and white; or tawny-brown, black and white, renders identification easy. In winter, however, the french-grey is largely replaced by a tawny shade.

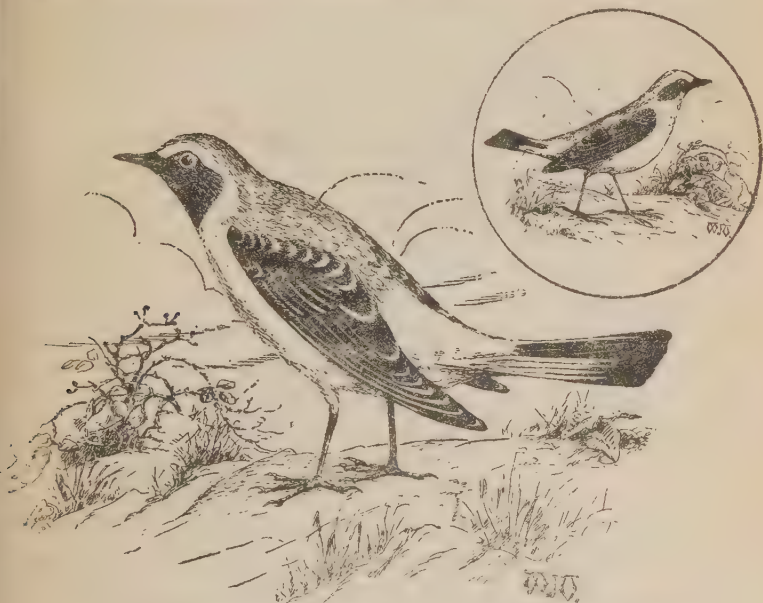


FIG. 75.—DISCOVERY OF THE WESTERN BLACK-EARED WHEATEAR IN IRELAND.
Common Wheatear, (inset).

"He was brimming over with energy—as vigorous migrants all are in spring—and finding himself in the company of many common wheatears... he was borne along to the Irish coast, and with many of his companions he shared the same fate by striking the lantern of an Irish light-station."

The wheatear progresses by remarkably long bounces or hops, and constantly makes a curtsy as he goes forwards. He is fond of alighting on mounds and stone-walls.

In becoming quite familiar with the habits, deportment, and plumage of our wheatear, you will be greatly assisted when

endeavouring to identify rare forms, should such cross your path. The movements of wheatears, as a race, are all alike, and contrast-colours in dress are the rule. (Fig. 75. inset.)

PLUMAGE OF WESTERN BLACK-EARED WHEATEAR.

Our Western Black-Eared Wheatear is a charming bird, and is endowed with still stronger contrast-colours than the common species. The forehead is silver-white, and the rest of the upper plumage is delicate, light golden-buff which, just above the white on the lower back and rump, is darkened by an admixture of grey shading. The face, throat, and wings, are black, the white tail being narrowly banded with a similar colour. The lower part of the throat is golden-buff, which still lower down becomes lighter in shade and passes into the buffish-white of the rest of the under plumage. The under wing-feathers are *coal-black*. In the female the upper parts are sandy-brown, the same shades predominating on the face and throat. (Fig. 75.)

AN ICTERINE WARBLER.

I shall now pass on to give a brief account of a casual visitor which was, in truth, a poor storm-driven waif, picked up on the rock at the light-station, in broad day-light, in a sadly emaciated state.

The bird was an *Icterine Warbler*, also a treasure, being the second only obtained in Ireland. Forty-eight years elapsed before this second specimen was obtained. The migration-routes, spread over the Continent of Europe, are situated to the east of the British Isles. But unlike the Aquatic Warbler and the Black-Eared Wheatear, the Icterine Warbler takes vast journeys when migrating. In returning northwards to its breeding-haunts in Norway, it penetrates inside

the Arctic Circle, and it has also an extensive breeding-range in Northern and Central Europe. But, like many other birds, its geographical distribution is by no means uniform. Some individuals, when on their northward travels, pull up in the latitude of the Mediterranean basin,

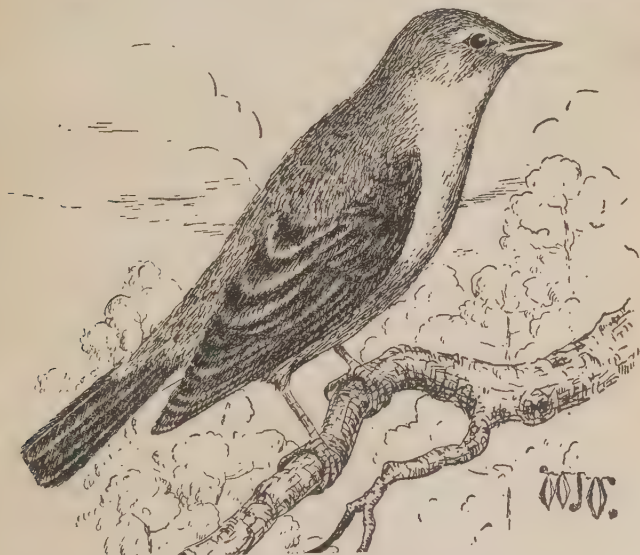


FIG. 76.—DISCOVERY OF THE SECOND ICTERINE WARBLER IN IRELAND

"In truth, a poor storm-driven waif, picked up on the rock at the light-station, in broad day-light, in a sadly emaciated state....this poor little waif probably became separated from its companions, then drifted aimlessly, and becoming fatigued, was forced to alight...at its last resting-place."

and breed in Sicily and Italy. In its southern travels in autumn, it penetrates Tropical Africa, some individuals passing on as far as 25° S.Lat., that is, they approach South Africa, well beyond the Tropical Zone. The bird therefore enjoys a second summer in the Southern Hemisphere.

AN ENERGETIC TRAVELLER.

Yes ; this warbler is a very energetic traveller, and can easily accomplish a journey from Norway to South Africa !

But now comes a very interesting point, which requires careful attention. This species breeds freely in Denmark, Holland, Belgium, and is abundant in North-East France. These countries are in close proximity to the British Isles : hence we should have expected to find visitors more often than they have been recorded.

We must however remember that, like a great many other warblers, its plumage is rendered quite inconspicuous, not only through absence of bright and contrast-colours, but also because the shades closely harmonise with the surrounding foliage, amidst which the bird for the most part spends its time. Hence it might easily escape detection. But, on the other hand, were it to arrive in the spring, and therefore permit us to hear its wonderful song, poured out with the utmost zeal, our attention would be at once arrested. If we should catch sight of this warbler, as it moves through the branches singing, we should see that the under plumage is lemon-coloured, ranging to a bright and very pure chrome-shade. Except in the *Melodious Warbler*, its near relative, we do not find this shade so emphasised in other birds of its kind. In fact the name *icterine* is derived from a Greek word meaning bile-coloured ; the tint of liver-juice being straw or chrome-yellow. As in the case of several warblers, the entire upper parts are olive-brown in shade, and a stripe of very pale straw-yellow passes above the eye.

AN OVERLOOKED MIGRANT.

Putting these facts together, it seems safer to say that in all likelihood the bird has been overlooked to a considerable

extent, and that many specimens which escaped being killed at the lantern travelled along the British and Irish coasts chiefly as *passage-migrants*. This warbler has such an extensive distribution, and its breeding-grounds come so comparatively close to our Isles, within sight of our coast, that one might expect a few pairs to nest with us from time to time. True, stray specimens have been obtained on several occasions in Great Britain. Therefore as a casual visitor the Icterine Warbler has caused less surprise than when it appeared in Ireland. But I am strongly of the opinion that Irish specimens have also been overlooked to a considerable extent.

The bird which I obtained was outward-bound, on its southern travels, and was very probably, in the first instance, blown out of its course, and from what we have learned in regard to its wide distribution, it is plain that the traveller would not require to make a great detour from its normal route to reach the Irish coast.

A LONE, EMACIATED, LITTLE WAIF.

At the same time, owing to its greatly emaciated condition, this poor little waif probably became separated from its companions, then drifted aimlessly, and becoming fatigued, was forced to alight; and it is likely that it made several attempts to reach its destination. It is reasonable to presume that originally it may have been wafted from its usual migration-route by stress of weather, that is to say fog or storm; however there is no reason to doubt that it had sojourned at other island-rocks, or such like inhospitable resorts, before it arrived at its last resting-place, where it was obtained dead and in a greatly emaciated condition.

I may add that this was the only specimen of the casual visitors recorded which was in this state of emaciation;

moreover, in regard to others not mentioned, nearly all were fat and in excellent condition.

From the foregoing evidence, we can now appreciate all the more fully how great is the endurance on the wing which birds possess, when obliged to embark upon an unusually protracted journey.

Remember, I mentioned, in the opening chapter on the migration of birds, that endurance on the wing was of primary importance; indeed a far more important asset than velocity of flight.

It is certainly marvellous to think that the tiny goldcrest can fly round and round the lantern for many hours at a stretch, even when its feathers become weighted by rain; truly a wonderful test of endurance on the wing! Without this endurance, the migratory factor would have long since ceased to function.

THE LONG-EXPECTED IRISH TREE-PIBIT.

Lastly, I must tell you about my discovery of the *Tree-Pipit* in Ireland. This bird differs from the preceding four species in that it is an abundant summer-resident in England except perhaps in the west of Cornwall. It is also common in Wales and plentiful in the south-west of Scotland, fairly common in the central area, but becoming rarer in the more northern counties and Scottish islands.

Owing to its wide geographical distribution on migration and its abundance, not only on the European Continent—especially the western section—but also in a large area of Great Britain, its appearance in Ireland had been certainly long expected.

Several observers repeatedly stated that they had seen the bird, but its claim to be included in the Irish List was

not admitted until I procured actual specimens from an Irish light-station. Curiously enough (though after all not altogether unexpected), a little time afterwards several others made their appearance at the same station. The first two visited the rock in day-light; the others struck the lantern at night and were killed outright. Of course we place the *first bird obtained* among the Irish treasures; it is preserved in the National Museum, Dublin. All the above were taken from one light-station on the east coast; in addition, however, a specimen was also picked up much about the same time, at another light-station on the east-coast. Furthermore, others were identified in subsequent years.

But there is reason to believe that this flank of the migration-wave may extend further west, for a tree-pipit was heard singing in the County Galway about the same time that the migrants were passing up the east coast. From the above data it is evident that this bird did not appear as a mere casual visitor.

Indeed I have little doubt that it had been overlooked to a considerable extent as a *regular passage-migrant* along the Irish coast. This is easy to understand, seeing that the tree-pipit in its form and in plumage closely resembles the meadow-pipit, and the latter is an abundant and ubiquitous species in Great Britain and Ireland. But on the other hand, the meadow-pipit only on very exceptional occasions alights on trees. I have seen it, for instance, dash into a hedge when hotly chased by a sparrow-hawk, and after the aggressor passed on, the pipit flew up and alighted on the branch of a tall tree. Cautiously on the lookout for a re-visit of its foe, it remained there for some time before taking to the open ground.

DISTINGUISHING HABITS OF THE TREE-PIPIT.

Tree-tops, are on the contrary, very favourite resorts of the tree-pipit. Here the bird often begins his song, but after uttering a few bars he ascends vertically for a short distance, hovers, and then planes down on outstretched wings, with tail spread and elevated, until his perch (the same spot) is reached again. The parachute-like way in which he descends, finely adjusting the speed so as to alight neatly on the topmost spray, is charming to behold. From the moment he leaves his perch (often before) until he comes down and alights upon it again, he sings his well-known brief stanza, in which the syllables *see-ar, see-ar, see-ar*, are pronouncedly uttered. These syllables are indistinct (and in many cases absent), in the song of the meadow-pipit, which otherwise is tinkling and resembles that of the tree-pipit in tone and rhythm.

The meadow-pipit sings on the wing, and always takes a longer excursion in the air than the tree-pipit.

THE CHEERY MEADOW-PIPIT.

I should think, my young friends, that you know both of these birds, and more especially the meadow-pipit; the latter, though not a garden-bird, is our constant companion at all seasons of the year, whenever we ramble afield over moorland, rough common, or pasture-land.

Sometimes on a gloomy day in a bleak spot, when all bird-life seems, as it were, hushed to sleep, the lively yet plaintive alarm-note of the meadow-pipit which resembles, *peep-peep*, or *cheep-cheep*, is indeed a gladdening sound.

More welcome still is the presence of the bird itself; of a sudden he springs up from his bower in the heather, and, alighting on a boulder, faces round to tell us that he is alert, but not afraid of our company.

A miniature bird, alone in its glory, amid such bleak and vast surroundings, brings us still closer into touch and sympathy with wild Nature's scenes. (Fig. 77, inset.)

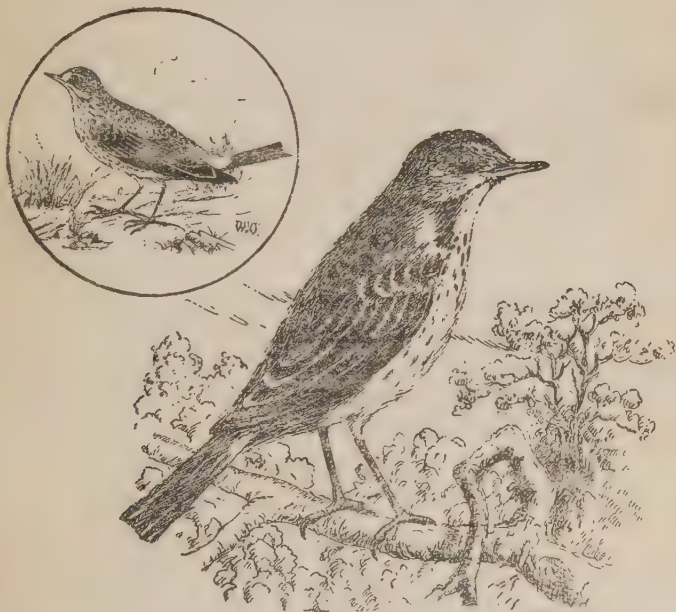


FIG. 77.—THE FIRST IRISH TREE-PIPIT.

Meadow-Pipit, (inset).

W O.

"Several observers repeatedly stated that they had seen the bird, but its claim to be included in the Irish List was not admitted until I procured actual specimens from an Irish light-station."

The tree-pipit is only with us half the year. Remember, he is a summer-resident. Nor is he strictly a garden-bird, though we should see him in a spacious garden planted with tall trees. Certainly we need not penetrate into the woods to hear and see him. He will favour us with his presence on the

tops of tall trees adjacent to plantations, or on trees which flank embankments, or skirt even high-roads in rural districts.

Here then we have two closely allied species which are identified, most readily, by their difference in habits of life, and not by their plumage.

TREE-PIPIT AND MEADOW-PIPIT VERY SIMILAR IN DRESS.

The costumes of these pipits are so alike that when a tree-pipit alights on the ground, he is indistinguishable from a meadow-pipit, except by an expert. The former however is stouter and stands higher, that is, he has a more upright bearing. It is not necessary here to describe in any detail the plumages, which in both species, and in common with those of many other birds, represent a somewhat primitive and ancient type, in which the ground-colour is brownish, spotted and streaked with darker shades. The ground-colour of the under parts is lighter, shading from warm-buff to whitish on the lower breast. The buff-colour is warmer in the tree-pipit, and the brown of the upper parts more sandy and less olive in shade than in the meadow-pipit.

THE DISTINGUISHING MARK.

There is however an unfailing mark by which we can always distinguish these birds, the one from the other. The claw of the hind-toe is very much shorter in the tree-pipit, and it is also strongly curved to enable the bird to perch adequately. In fact the hind-toe with its claw is built on the same plan as that of any ordinary perching-bird, such as a sparrow, a chaffinch, a blackbird, or a thrush. (Fig. 77.)

The claw of the hind-toe in the meadow-pipit is very long, tapering, and almost straight. Thus the hind-toe with its claw resembles that of a skylark rather than of a typical perching-bird. The difference in the form of the hind-toe in the two

pipits is most striking, but of course can only be determined at close quarters. Hence a visit to the museum would prove most profitable. (Fig. 77, inset).

It should be mentioned also that the colour of the foot is distinctly lighter in the tree-pipit. In the fresh specimens, which I obtained and examined, the shade was delicate pale flesh-colour, almost comparable to ivory-white, with the faintest trace of pale pink. In the meadow-pipit the foot is tinged with a robust shade, ranging from yellowish-brown to horn-colour. (Fig. 77.)

So much, then (in so far as we have been able to study in this chapter), for problems in regard to *Casual Migrants of the Old World*. The various ways in which such travellers—whose fly-lines are not set in the direction of the British Isles—manage to reach our shores, have been tentatively explained.

It seems quite within reason to suppose, nay more ; it is strongly presumable, that casual migrants are often induced to stray far from their beaten track, through following the fly-lines, not of their own, but of allied species.

Evidence of piloting has been fully before us : the problem therefore deserves close attention.

In continuing our investigations of this fascinating theme, new and most interesting facts will come to light which, no doubt, will materially assist us to unravel several knotty problems in respect to the marvellous migratory movements, which American birds can accomplish in their endeavours to reach our Isles.

Here a note of warning must be struck. The evidence of genuine Trans-Atlantic migrations requires most careful sifting. That certainly we shall see for ourselves, when, in the pages of the next chapter, we read the strange story of the adventures of an American Goldfinch.

LECTURE 19.

CHAPTER XXX.

THE ADVENTURES OF AN AMERICAN GOLDFINCH.

A STRANGE STORY WITH A USEFUL MORAL.

A stroll on the beach—Eventful meeting—A shaggy, glittering-eyed old skipper arrives—He holds in his hand a small bird—He tells the story of its capture—A ‘sailor’ and his cap—Bird easily caught—A fatigued migrant, just arrived—An American Goldfinch—Great prize—Genuine Trans-Atlantic traveller—So the ‘sailor’ said and believed—The old man too readily followed suit—He felt very proud of the discovery—But who was the ‘sailor’?—Where did he hail from?—What was he like?—No one could tell—The mystery deepens—Was he a phantom?—The skipper grows suspicious on being cross-examined—Very uneasy—Fears of being looked upon as an impostor—Admits his romance—The sailor lived in his imagination—Confesses that he captured the bird—Humbly asks pardon—Agrees that the bird did not fly across the ocean—The goldfinch examined—Very poor in condition—Plumage sullied—Flight-feathers frayed and worn—An escaped prisoner—Undoubted evidence—The skipper closely questioned in regard to local bird-fanciers—A trot on horse-back across the sands—Mr. Leatherstitch, the cheery-faced cobbler, at home—His weird, wooden, shanty full of birds in small cages—Four American goldfinches on view—Six originally—One died—One escaped this morning—Mr. Leatherstitch espies his lost bird. He falls into a state of great emotion—In passionate tones he begs back his favourite songster—The kind-hearted old skipper restores it, and we put it back in its cage—The cobbler deeply grateful—Rewards Mr. Hunter with half-a-crown—In conversation the skipper’s name now divulged—He was a silly old trickster—Tried by false

pretence to establish a British record of a New World Casual Migrant—He failed in his stupid, clumsy attempts — The trick has been tried more than once — Genuinely repentant—Freely forgiven — An interesting personality, despite his impudent bluff—He loves birds, so we shall keep him in our company in the next chapter.

SURELY a strange story: that we shall all admit. Nevertheless, it is founded upon fact, and portrays a picture of a danger with which the student of Nature, in his search for truth, may at any time be confronted. Fortunately when the tale has been unfolded, its moral, sound and practical, looms up and guards against the threatened pitfalls. It behoves you therefore, my young friends, to lend an attentive ear while I recount the episode.

I was strolling along the beach when I met an old man who possessed a "long grey beard and glittering eye." Quite possibly he bore some semblance to the 'Ancient Mariner.' But I cannot say, not having had the pleasure of that gentleman's personal acquaintance! I shall call him the old skipper, because he certainly did remind me very much of the veteran who turns up from time to time in the picture when we go hunting for a delectable brand of sardines! Likewise he wore a sou'wester oil-skin cap. In one hand he clasped a goldfinch. The little creature shewed no particular signs of alarm; in fact it seemed, from its soft, contented, expression of eye, as though it had long since been a pet. The old skipper made a most emphatic statement to the effect that on the bare sands he watched a 'sailor' capturing the bird by throwing his cap over it. Then, for the possession of the captive he paid the captor sixpence.

Strangely enough, when I ventured to make merely a few general enquiries in regard to this interesting specimen, a most mysterious, furtive expression seemed to veil the old man's glittering looks. He forgot the name of the sailor;

forgot what he was like in appearance ; forgot where he lived. I was not long in ascertaining that no sailor whomsoever was known to any of the inhabitants for miles around the district.

" Perhaps," said I, apostrophising the old man, " the sailor's name was Mr. Harris and that you saw as much of him in real life as Sarah Gamp saw of Mrs. Harris."

You recollect, my young friends, in ' Martin Chuzzlewit ' that the notorious Sarah had a habit of repeatedly referring to an imaginary Mrs. Harris !

The old skipper looked very awry ; nevertheless, he was extremely proud of his captured goldfinch. Then, of a sudden he blurted out, loudly and impulsively, " I thoroughly agree with the sailor's theory ; this bird must have travelled all the way across the Atlantic Ocean ; it had only just arrived on British soil when it was made prisoner."

He seemed somewhat surprised when I informed him quite casually that the aerial trip across the Atlantic would entail over three thousand miles. To accomplish this flight, the miniature migrant in question would require *super-avian velocity and endurance on the wing*. By watching his demeanour when he heard the few telling remarks which from time to time I threw in, and by continuing to listen attentively to his yarn, it soon became an easy matter to read between the lines.

THE SKIPPER'S YARN.

The fact was he was now trying hard to persuade me to believe in the ridiculous idea that the bird actually did fly without assistance all the way from America to the British coast. Hence, in order to convey to his mind that I entertained grave doubts as to the truth of his story, I started to cross-examine him.

"Tell me," I said, "What would have been your opinion regarding the travels of this goldfinch, supposing that it had been you and not the 'sailor' who had picked it up on the beach?"

It very soon began to dawn on him that perhaps I knew something about birds; perhaps, after all, I was an expert ornithologist. It became evident that he detected by my searching glance that his tall yarns were of no avail.

He replied, "Sir, I would have submitted the bird instantly for your examination, instead of keeping it almost hidden all this time in my hand."

"Very good," I said; "may I examine the bird now?"

"With pleasure," replied the old skipper, to which he added, "and in handing it over to you, sir, I should like to confess that I have changed my mind, and now disagree wholeheartedly with the sailor's idea. No, no, sir, the bird never could possibly have crossed the vast open Atlantic."

Then, I said, "Tell me the *whole* truth and shame the devil. Who was the sailor who discovered and picked up this goldfinch?"

He answered, "He was myself, sir; no one else"

"Ah! now I see. You and your imaginary sailor, your phantom Mr. Harris, are one and the same person, eh?"

THE SKIPPER KNEW SARAH GAMP.

"Yes, sir; I frankly admit it, as surely as Sarah Gamp and Mrs. Harris were one and the same person."

"Have you read many of Dickens' books? I enquired.

"I have indeed, all of them sir, and with great relish."

I took the little finch tenderly in my hand and examined it. O my dear young friends! What do you think that I discovered? The plumage, sad to relate, dreadfully poor

and dirty ; the long feathers of the wings and tail worn down and frayed. The toes caked with excrement, and the claws overgrown and blunted at their extremities.

Surely, before I proceed further with my story, you can tell me, from this pitiful picture, where this little bird had come from when the wily veteran ensnared it with his cap.

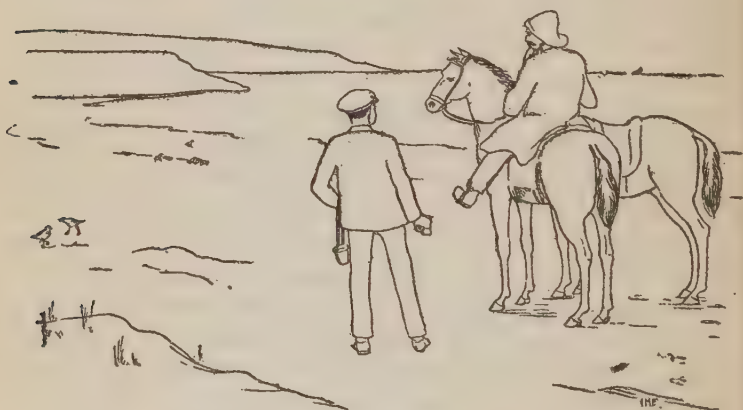


FIG. 78.—ACROSS THE SANDS ON HORSE-BACK.

"Very well,"..."we must try and forget your stupid behaviour this time ; take me now to see Mr. Leatherstitch. How can we reach him?" "Can you ride sir"..."Yes ; I shall be very glad to have a trot along the sands." "We found Mr. Leatherstitch at home...surrounded by small birds in very small cages ! The captives were in none too good plumage. At once I identified four American goldfinches."

Yes ; from a cage. The goldfinch was naught else than an escaped prisoner which had been re-captured !

Before passing an opinion as to the bird's powers of crossing the Atlantic, in its present state of plumage and general bodily condition, I asked the old skipper if he happened to know any bird-fancier in the district.

"Sir," said he, "the only bird-fancier whom I know is Mr. Leatherstitch, a poor, lean, cheery-faced cobbler, who mends boots and shoes. He lives full five miles off in a small wooden hut, a strange, rickety shanty, adjoining the seashore. He keeps canaries, and a few linnets and goldfinches, but none like this one, at least as far as I am aware, which being an American bird is marked very differently from our British goldfinch."

"Then this one is an *American Goldfinch*; how do you come to know that interesting fact?" I interrogated.

"Because, sir," he replied, "I have seen stuffed specimens labelled in the museum."

"Then," I remarked, "you are really much interested in birds?"

"Tremendously so, sir, and I humbly claim to know something about their habits and plumages."

"Very good, indeed," I said; "that being so, what put it into your head to say that this goldfinch, in such miserable plumage and general bodily state, could have possibly crossed the open Atlantic? Why, even in good plumage a finch could not perform so protracted a journey."

HONOUR AND GLORY SOUGHT DISHONOURABLY.

"Well," said he, "to tell you the honest truth I was excited and I wanted to have the honour and glory of recording a *very rare casual American visitor*, but when I learned by your searching looks and questions that you knew all about birds, far more than I do, I withdrew my statement."

"The 'honour and glory' which you were ambitious to obtain were not sought for in an honourable way: I sincerely hope that you did not want to tell a deliberate untruth?"

"No, believe me, no, sir; and may I ask your humble pardon for even trying the game of bluff. I hope, sir, you will please forgive me."

"Very well," I rejoined, "we must try and forget your stupid behaviour this time; take me now to see Mr. Leatherstitch. How can we reach him?"

"Can you ride, sir," he suggested.

"Yes; I shall be very glad to have a trot along the sands." (Fig. 78.)

We found Mr. Leatherstitch at home and extremely busy at his work: he was surrounded by small birds in very small cages! The captives were in none too good plumage. At once I identified four American goldfinches.

"Mr. Leatherstitch," said I, addressing the lean, cheerful cobbler, "where did you get your American goldfinches?"

"In America, sir," said he, "when I was on a visit there twelve months ago; aye, I brought home six of these lovely birds. Now I have only four left."

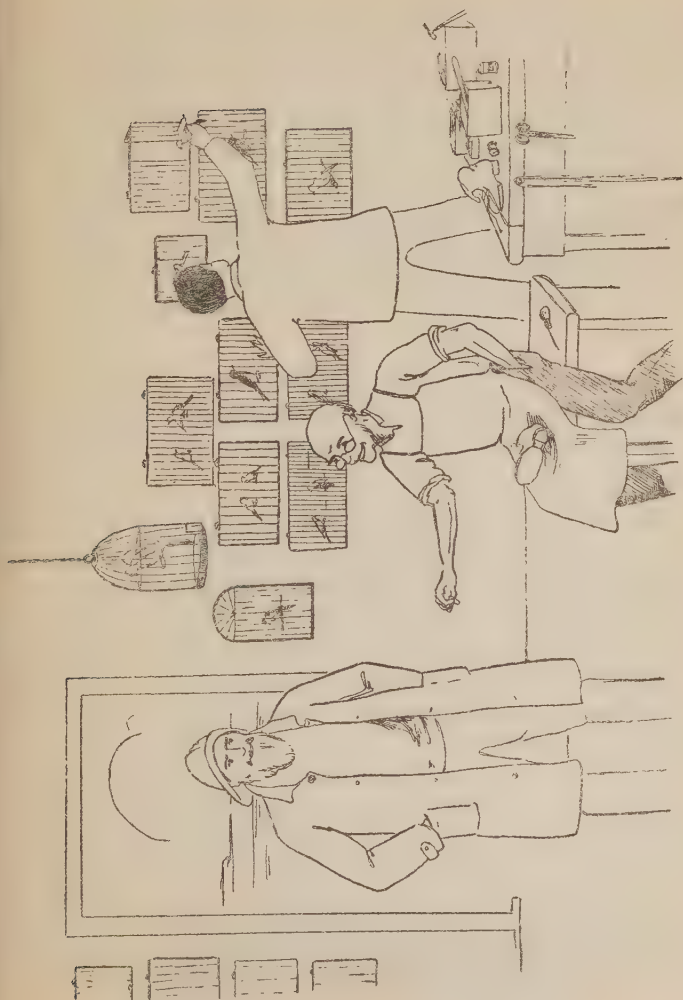
"Pray how is that?"

"Well, you see, sir, one died two months ago, and one escaped yesterday when I was cleaning out its cage. Worse luck, too, because it was the only cock bird left, and O my word he was a glorious singer!"

"May that be your bird," said I, shewing him the recaptured captive?"

MR. LEATHERSTITCH, THE COBBLER, WILDLY EXCITED.

"Aye, aye," he ejaculated, in a state of wild excitement: "where did you drop on it? O may I have it back? Look, sir, there is no doubt about its being mine. See! it is heavily moulting!"



J m t

FIG. 79.—THE COBBLER REWARDS THE SKIPPER.

"Well," said the cobbler, cheerfully, "here is my very best thanks to you, Mr. Hunter; pray accept half-a-crown, as a modest reward from a poor man."

To his last remark I made no reply, knowing full well that the miserable state of the plumage was not due to a natural moult, but rather to the flutterings of the poor little prisoner against the bars of much too small a cage.

"The bird is not mine to restore," I replied. The old man caught it this morning by throwing his cap over it."

"Oh, dear! Oh, dear! So you caught my little pet Mr. Hunter? Ah! well done!" (Incidentally, now I ascertained the old skipper's name).

"Yes, I did; I caught your goldfinch easily. It was very tame, Mr. Leatherstitch."

"Yes, indeed," replied the rightful owner, "it is a very tame and an affectionate bird; you could have picked it up with your hand, Mr. Hunter. Am I to have it back again?" enquired the cobbler.

"Why, surely," replied the skipper, with a generous but business-looking twinkle in his eye; "to whom else could it belong—you are the only person who keeps American goldfinches in the country. "And mind you, Mr. Leatherstitch," he added with emphasis as though anxious to parade his knowledge of birds, "never be persuaded by anyone to entertain the foolish idea that an American goldfinch could fly across the Atlantic Ocean. I do not believe that in its present condition, the bird, which I have had the pleasure of capturing and restoring to you, could have flown the length of your back-garden. It must have fluttered along in easy stages to the spot where I found it this morning."

No doubt it was now a source of mental relief to Mr. Hunter to emphasise the truth in my presence once more, in regard to the adventures of this American goldfinch!

THE COBBLER REWARDS THE SKIPPER.

"Well," said the cobbler, cheerfully, "here is my very best thanks to you, Mr. Hunter; pray accept half-a-crown, as a modest reward from a poor man." (Fig. 79.)

So the American goldfinch was once more put behind the prison-bars, where it lived and sang sweetly, a captive, for two years longer; at the end of that time it was found dead one morning. It succumbed in that quiet, almost mysterious, way which seems so characteristic of the final scene of many cage-birds.

MORAL OF THE STORY.

Such, then, is the story of the adventures of this American goldfinch; a story founded on fact, and one worth while relating, for it conveys an important message and moral, which, doubtless, you have already appreciated.

Mistrust and suspicion, without adequate reason, are unwarranted and quite undesirable traits in human character. Unless we have good reason to disbelieve a statement, it is better to err on the side of being credulous than wholly sceptical, because doubt, not backed by reason, is often a sign of mere stubbornness. Wholesome scepticism, on the other hand, is often the safeguard against *blind* faith, which is an unpardonable sin. But if in your opinion (that is to say in the light of the knowledge you possess), a statement seems unlikely to be true, then by all means be careful to sift the evidence.

Some people have such fertile imaginations that, in the innocence of their heart, and with the best of intentions, they really believe that they see rare birds in most unlikely

places, perhaps repeatedly. A visit to the spot by another observer with a more analytical but less unduly imaginative temperament, often proves the contrary; the *rara avis*, being usually a common species seen under singular circumstances, such as from a peculiar angle, under unusual illumination, and so on. It is not uncommon for persons to say that they heard or saw such and such a bird, without adequate evidence to support their statement. Such records when put into print must at first be regarded tentatively. Time may corroborate and strengthen them; on the other hand, they may fizzle out and prove untenable.

In Science (as in all other pursuits of Knowledge), we should train our minds to keep on analysing and sifting the true from the false, the gold from the dross. On the whole, people try to be honest and help on the cause, whatever it may be, by statements they think honest.

But we cannot get away from the fact that there are impostors in the world. Forewarned is forearmed, and it would be unwise to discountenance the existence of these mentally unbalanced persons.

Still, there are impostors and impostors, and not only the sins, but also the motives, of some are far blacker than those of others.

A REPENTANT TRICKSTER FORGIVEN.

Mr. Hunter, an aged man whom I had not met before, tried by a piece of impudent bluff to establish a record, in order to place the American Goldfinch on the British List of Birds. His tactics were so clumsy that we hardly think he was a downright impostor. Surely it must have occurred to him that anyone with but a limited knowledge of birds, on seeing the miserable condition of his specimen, would

have had the common sense to call seriously into question the veracity of his story.

In a state of excitement he made a stupid attempt to hoodwink—so stupid that the attempt could not possibly hold water for any length of time. It defeated its own end.

His refutation of his statement when questioned ; his frank admission of such stupid behaviour ; and his genuine repentance ; all go to show that he was a trickster rather than an impostor, acting under the strain of great mental excitement. But I was well up to his little game, and his attempt signally failed.

He is not the first trickster I have come across who has approached the question of establishing, by false statements, British records of supposed rare birds. We are all liable to meet some such persons sooner or later in our studies of birds. That, in a nutshell, is the real moral of the story. That is why I spun this yarn. That is why I finish by saying we must always exercise caution, and weigh the evidence when sifting the truth.

But we have freely forgiven Mr. Hunter, and as he is an interesting and intelligent old man, and genuinely fond of bird-studies, we shall shew good-will by inviting him to join us in discussing some knotty points regarding the Trans-Atlantic migrations of *Casual Visitors from the New World*. We shall pursue this fascinating enquiry in the next chapter.

CHAPTER XXXI.

PROBLEMS IN REGARD TO TRANS-ATLANTIC MIGRATIONS.

CASUAL VISITORS FROM THE NEW WORLD.

Migrants and ships—The question of assisted passages—Mr. Hunter consulted — His highly suggestive reply — Casual migrants do not invariably depend upon assisted passages—Vigorous migrants seldom attracted by ships—Fatigued migrants endeavour to alight on vessels near or remote from land—Personal observations—Mr. Hunter raises the question regarding evidences of American birds which have escaped from British aviaries — Wanderings of American water-birds from ornamental ponds—Summer-Duck—Story of supposed Trans-Atlantic journey—Evidence to the contrary—Specimen dismissed from the Irish list—Birds which have accomplished the Trans-Atlantic flight—Gulls—Terns—Sandpipers—The seaweed 'raft'—'Robinson-Crusoe' episode—Corn-Crake—Surprising migrant—Lighthouse evidence—Flight—High velocity and altitude—Personal observations—Vast wanderings—Carolina Crake—Equally swift and strong on wing—An abundant American bird—Extensive distribution—Has reached the British Isles—Two most likely routes pursued by New World Casual Visitors—Northern—Via Greenland, Iceland, Faroes, Shetlands, and Orkneys—Southern—Via coasts of Tropical South America and West Africa, thence northward by coastal route to British Isles—The aid of escorts—The story of a Carolina Crake obtained in Ireland—New casual visitor—First recorded specimen—Genuine Trans-Atlantic traveller—Convincing evidence—A highly treasured prize from America—Short description of the specimen—Its dress compared with that of the corn-crake—Mr. Hunter much enjoys the discourse on plumage-markings—We part company—Farewell and Good Luck.

AS we strolled back from the cobbler's hut (preferring to go on foot rather than horse-back), we had a most enjoyable chat about bird-migration. Presently it occurred to me to put a leading question to my veteran companion.

"Supposing," I said, "that I were to show you a small American land-bird, perfect in plumage and condition, hence shewing no signs of having been a captive: and supposing that it had been shot, or was killed by striking the lantern of a lighthouse, or that it came by its death suddenly in yet another way, but in any case was procured in our Isles immediately after it met its fate; in what manner would you think that the Trans-Atlantic voyage was accomplished?"

The old skipper replied that most likely the bird obtained an assisted passage on an east-bound steamer, and if the migrant had to quit the vessel, through being scared away, it might have had the good fortune to board another and enjoy a further lift.

I considered the theory was plausible and sound as far as it went. However, I pointed out that there was evidence to shew that when a bird boarded a steamer or other craft, this did not always mean that the trip would be necessarily completed, even if the little traveller stuck to the ship until she put safely into port.

THE PROBLEM OF ASSISTED PASSAGES.

I explained that much as birds may be endowed with the faculty of direction, it was pure fancy to assume that they can form any definite idea in regard to a ship's destination.

"Mr. Hunter," I said, "I have crossed the North Atlantic several times, and have often witnessed the migratory move-

ments of birds far out on the boundless ocean, and have seen them come aboard ships on many occasions. I have observed American birds, flying east, alighting on west-bound vessels; and British birds, flying west, alighting on east-bound vessels. In such cases it is obvious that the travellers were taken back to the country from whence they had originally embarked! The larger and strong-winged species might have crossed the ocean if they had not happened to go aboard; or more likely still, if they had alighted on a vessel proceeding in, and not against, the direction of their migratory-routes. Consider the case of a wheatear which I observed flying west: this migrant came on board about 900 miles west of Greenock. The vessel was east-bound, and the bird remained on the ship until we *hugged* the north coast of Ireland; then it flitted off to land. The wheatear is one of our smaller land-birds, but it has long and muscular wings. If this bird had not alighted on an east-bound vessel, it might, with one or two short assisted passages, if given a spell of fine calm weather, have managed to reach the American coast. Had it met a vessel west-bound, as yet only 900 miles west of Greenock, and then had alighted, it would have booked for itself a lengthy assisted passage! The vessel would have eight days still to run, and mind you, Mr. Hunter, birds which remain on board take great risks, though food may be available. I well remember a chipping-sparrow (a very common American bird), flying east when we were only about 33 miles from Quebec. This bird boarded our vessel, west-bound for Montreal. Obviously the chipping-sparrow was brought back safely to its native country. If it had strayed further eastward and embarked on an ocean-flight, it is to be feared that disaster would have followed in its wake."

"It is evident, then, Mr. Hunter, that *casual visitors* from the New World do not depend only upon the existence of Trans-Atlantic vessels to convey them to our shores. All American birds which have been admitted to the British List need not necessarily have had assisted passages. Considering the vast multitudes which migrate, it is at first sight surprising rather than otherwise, that so few proportionately do come on board. One would expect the travellers to alight more frequently and in larger numbers, not only on Atlantic *Liners* but also on ships sailing on lesser seas, and especially on those vessels which traverse or direct their course along the main migration-routes. Can we offer an explanation? It seems reasonable to infer that as long as birds are strong and vigorous on the wing, and in fair weather can hold their own, they are not attracted by ships. If, on the

WHEN THE SHIP ATTRACTS THE TRAVELLER.

other hand, the migrants become thoroughly played out through stress of weather, or if they become scared by the presence of predatory birds, then they will be glad to rest, sometimes in great numbers. In such instances it is often quite indifferent whether the vessel be large or small; near or remote from land."

"I recollect approaching and easily photographing a very fatigued meadow-pipit which alighted on board a cross-channel steamer. I have almost stroked a terrified greenfinch which, being pursued by a hawk, dropped on to the deck of a small coasting *tug*—a relief vessel which attended on light-stations." (Fig. 80.)

"Several birds, which I have personally collected from vessels, have not exhibited the plumpness of regular vigorous migrants; indeed not a few were much under average weight.

A common sandpiper which I collected on board a steamer in the Indian Ocean, was in a pitiful state of emaciation. Now it is noteworthy that sandpipers, as a race, are just the species which undertake and accomplish amazingly long journeys, and no doubt if this bird had been in a vigorous state of health it would have shunned alighting on the ship."

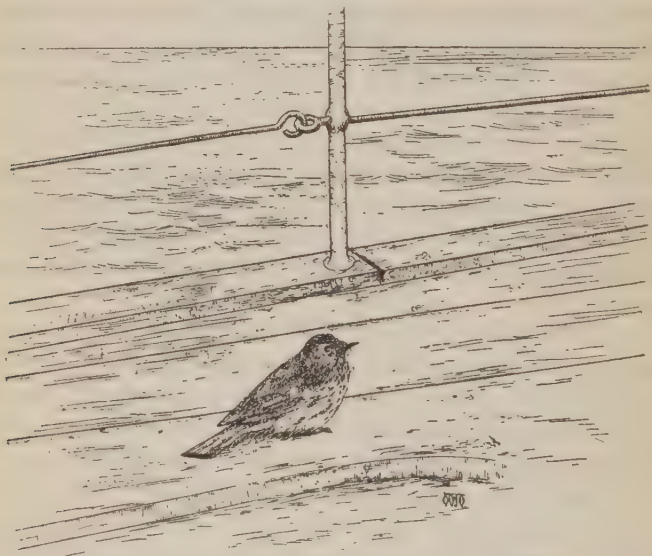


FIG. 80.—A MEADOW-PIPIT ABOARD SHIP.

"I recollect approaching and easily photographing a very fatigued meadow-pipit which alighted on board a cross-channel steamer."

"Therefore you see, Mr. Hunter, that the question as to how small land-birds manage to reach our shores from the New World, is still very puzzling. There are many problems still awaiting solution. As a matter of fact very few small American *land-birds* have been recorded on the list of '*Casual British Visitors*.' But here again we must bear in mind that numbers have been overlooked."

THE MIGRATORY ROUTE OF ARCTIC AMERICAN VISITORS.

"We can substantially add to those already on our list if we include *Arctic American visitors* which travel to our shores by way of Greenland, and thence by the north-western groups of European Isles. While such a route may prove somewhat circuitous, it is obvious that many stopping-places are offered. In that way the vast expanse of boundless ocean is avoided. Several species native to Greenland, such as the Greenland Falcon, the Greenland Wheatear, the White Wagtail, and others, when on migration, reach our coasts by this route. These birds are placed in a very different category; they are by no means rare; on the contrary they are well-known passage-migrants to our Isles."

"The migratory movements, therefore, of birds native to Greenland, and of those birds which are distributed in more southerly latitudes in America, offer two markedly different problems; *the former easy to solve, the latter most difficult*. In short, we may say that, barring the native birds of Greenland, the small land-birds from the Continent of America very seldom reach our Isles; and hence when they do appear, must be regarded as *very rare casual visitors*."

"Well now, sir, may I offer a suggestion," said the old man, as his eyes lit up.

"Yes, please do, Mr. Hunter, I have been talking, I think, too long."

"No, no, sir," he politely rejoined, and then began.

ESCAPED PRISONERS.

"Might not birds, sir, in very perfect plumage, sometimes escape from large open-air aviaries—for instance from the aviaries of Zoological Gardens, where the inmates keep in such splendid plumage and condition?"

“A capital suggestion, Mr. Hunter : certainly one which we should bear well in mind. In practice, however, we find that very few prisoners make their escape from such enclosures. But here let me remind you that many species of American *water-fowl* which have been recorded and indeed shot, apparently in a wild state, along the sea-coast or on sheets of fresh-water in our Isles, turn out frequently to be escaped prisoners from ornamental ponds ! We have a good example of this in the Canada goose, which is black and white in plumage and not unlike our British barnacle goose, though considerably larger.”

EXCITING STORY OF A SUMMER-DUCK.

“I remember, when I was a lad, obtaining from the mouth of the River Liffey, Dublin, in the dirty waters where all the busy shipping-traffic was at its height, a *Summer-Duck*, in magnificent plumage ; I tell you, he was a very handsomely-marked fellow. Oh ! I was filled with joy, and wild with excitement at the very thought of being the discoverer of this American duck in Ireland ; because up to the date of this capture, no specimen had ever been recorded as having occurred in a wild state in the Emerald Isle !”

“Alas ! on shewing the specimen to a friend, older than myself and very much better versed in bird-studies (indeed, he was an expert in the Bird-Department of the National Museum, Dublin), my great enthusiasm was soon damped, for the verdict he gave was : ‘an escaped prisoner from an ornamental pond !’

“Nevertheless, it is quite true, Mr. Hunter, that some water-birds do manage actually to reach our shores from the New World : ducks and geese, yes ; also gulls and terns, but more especially shore or wading-birds comprising members of the

A Stately Visitor from Greenland.



(Photo of a specimen mounted by Messrs. Sheel.)

A Masterpiece of Taxidermy.

GREENLAND FALCON.

"Arctic American visitors....travel to our shores by way of Greenland, and thence by the north-western groups of European Isles....Several species native to Greenland, such as the Greenland Falcon, the Greenland Wheatear, the White Wagtail, and others, when on migration, reach our coasts by this route."

large and varied family of sandpipers, plovers, and their allies. No less than a score of different species of American shore-birds have been admitted on the British List."

"Sandpipers are endowed with wonderful powers of flight. I feel quite convinced that when they once get fairly under way, and if given fair weather conditions, they can make a long non-stop dash through the air in an astonishingly short time."

"The glancing flight of a redshank, a greenshank, a dunlin, or of the most fairy form of shore-bird, the little stint, over the ocean-waves, at a speed exceeding one hundred miles an hour, is truly an amazing performance."

A RAFT IN MID-OCEAN.

"Ships certainly offer the most reliable hospitality in adverse weather. Nevertheless, sandpipers at times have their 'Robinson Crusoe' adventures on the 'raft,' though perforce of short duration."

"I have seen a small party of sandpipers resting on a patch of floating seaweed far out in the North Atlantic. As we steamed past, some of the birds, disturbed by the wash of our vessel, slipped into the water, but they managed to clamber up again, and though it was very difficult to gain a steady foothold, they were able to rest their wings for a little while." (Fig. 81.)

"Field-ice could readily afford a footing for aquatic birds, and doubtless scraps of floating wreckage have more than once provided 'rafts' which have been the means of saving many fatigued migrants from going down in the waves. All this is very wonderful: but a more wonderful revelation has been made in regard to bird-migration!"



FIG. 81.—A RAFT IN MID-OCEAN.

"Sandpipers at times have their 'Robinson Crusoe' adventures on the 'raft'....I have seen a small party of sandpipers resting on a patch of floating seaweed far out in the North Atlantic. As we steamed past, some of the birds, disturbed by the wash of our vessel, slipped into the water, but they managed to clamber up again, and though it was very difficult to gain a steady foothold, they were able to rest their wings for a little while."

REMARKABLE MIGRATIONS OF THE CORN-CRAKE.

"The Corn-Crake ascends into the air very heavily when put up from a meadow by a dog ; moreover this bird seldom proceeds far without alighting. Sometimes it will even drop down in the same meadow. Yet when on active migration it travels with great speed, and can cover vast distances without becoming fatigued. For instance, in its wanderings from South Europe and North Africa, when steering northward for its breeding-areas, it has reached the coast of Greenland, and several times that of North America and the Bermuda Isles. More remarkable still, a south-bound traveller has been recorded from New South Wales, Australia ! "

"I have seen many corn-crakes dash themselves against the lighthouse-lantern with terrific force, and at an altitude of some two hundred feet above the sea-level. This clearly shews, contrary to popular belief, that the bird can fly at a considerable height above the ground, and with great power and velocity."

"We are all very well aware that the corn-crake is an abundant summer-resident in our Isles, arriving in mid-April or early May, and departing for more southerly climes in September and October. Likewise, on passage to and from more northerly latitudes in Europe, it passes along our coasts in great numbers. In the New World, we find that its cousin, the *Carolina Crake* (also known as the *Sora Rail*), is equally swift and strong on the wing."

DISTRIBUTION AND MIGRATION OF THE CAROLINA CRAKE.

"The Carolina crake is a good example of an American bird which is very abundant, and at the same time has an extensive geographical distribution. Northwards it breeds as high as Labrador, migrating a little beyond Lat. 60° N.,

which in Europe corresponds to the latitude of the Shetland Isles. The southern quarters reach Tropical South America, extending a few degrees below the line of the Equator. Individually there is very considerable variation in the range of travel. Some birds halt to spend the winter in California ; others in the West Indies ; and others in Central America."

" This variation in the fly-lines of individual birds is very noticeable. We have already studied it in the case of many other species of migrants. It is highly suggestive that the very extensive geographical distribution of the Carolina crane serves as a factor in enabling it to reach the British coasts by one of two routes. Thus, an easy trip could be made across from Labrador to Greenland, thence to Iceland, from which our Isles could be conveniently reached by way of the Faroes, Shetlands, and Orkneys. Or a dash across the open ocean might be ventured upon from the most easterly point of Tropical South America (included within the confines of the bird's extensive distribution), to the nearest point on the coast of West Africa. Here the ocean-journey would be shorter than if undertaken in higher latitudes, where we note on our maps that the North Atlantic Ocean is considerably wider."

" On reaching West Africa, our American visitor would fall in most likely with hundreds of Old World migrants, all travelling northwards by way of the western sea-boards of Africa and Europe, some heading for the British Isles. Furthermore, our Carolina crane most likely would join company with hundreds of corn-crakes, and by the help of such an escort would manage to reach our coasts."

" Mr. Hunter, I can tell you something still more wonderful ! "

A CAROLINA CRAKE WHICH REACHED IRELAND.

"I actually obtained a specimen of a *Carolina crake* from a lighthouse, on an island off the west coast of Ireland. Therefore your interests in the migrations of this bird will be roused a thousand-fold. The bird killed itself by striking the lantern with tremendous force, a sure sign that the victim had been travelling at very high speed. Rails and crakes are wont to strike with great force, and in my personal experience I find that they nearly always kill themselves outright."

"The bird was in excellent condition and in perfect plumage, and I have little doubt that being a vigorous migrant, it completed the Trans-Atlantic journey without an assisted passage aboard ship."

"What a very valuable prize for the National Museum, Dublin: *the first Irish specimen*, and only the fifth record from the British Isles for the past sixty-four years!"

"The question arises—What route did the migrant select? Here we are presented with an extremely interesting problem. I believe a reasonable solution is forthcoming. Note in the first place that the bird was obtained on April 11th. At that early date its spring movements along the American Continent would not have become general; indeed in the northern area of distribution its migrations would not yet have started. Greenland would still be in the grip of ice and snow. Put these facts in sequence and I think we are safe in saying that the inhospitable northern or Greenland-route may be set aside."

ROUTE TAKEN IN TRANS-ATLANTIC FLIGHT.

"It seems to me probable that at this *early* date, the usual fly-line northwards along the Atlantic-facing American

sea-board was very soon abandoned, and that the ocean-trip was started about the latitude of the Equator.

As already explained, the western sea-board of the Old World could be reached sooner than if the trip were begun at a higher latitude.

In regard to our *Carolina Crake*—the Irish prize—I am strongly of the opinion that after a short movement northwards along the east coast of Equatorial South America, a dash across the North Atlantic was made, say from Cape St. Roque (the most easterly land of South America), to Sierra Leone. Arriving here, the bird would move probably northwards along the western sea-boards of Africa and Europe to the British Isles."

"Hundreds of Old World migrants would be migrating at the time, and the American visitor would be glad to join company. His near cousin, the corn-crake, migrating in hundreds, would most likely form the chief escort to the British Isles."

DESCRIPTION OF THE TWO CRAKES.

"Now I am sure, Mr. Hunter, that you would like me to give you a short description of the Carolina crake."

"That I should, sir, immensely, thank you," was the old man's warm-hearted reply.

"Well then, in regard to form and deportment, this bird is an exact replica of a corn-crake on a reduced scale. But am I sure that you are familiar with the appearance of the corn-crake? Many people know the name and the voice, yet not the bird. Is not that so, Mr. Hunter?"

The skipper assented with a series of rapid little nods, pursing his lips tightly and closing his glistening eyes at the same moment.



A.—CORN-CRAKE.

"The corn-crake is, as it were, an individual with a fair or ruddy complexion."



B.—CAROLINA CRAKE.

FIG. 82.—DISCOVERY OF THE CAROLINA CRAKE IN IRELAND.

"The Carolina crake is an individual with a dark complexion!"

"What a very valuable prize....the first Irish specimen."

“Picture in your mind, Mr. Hunter, a light cinnamon or reddish-brown bird, the size and shape of a half-grown domestic chicken, but with longer toes, more crouching gait, and much narrower breast, which from side to side appears compressed. I believe that this comparison will enable you to form a good idea of a corn-crake. But the tail-feathers are not carried erect like those of the full-grown domestic fowl. On the contrary, they arch downwards as a continuation of the rest of the curve of the back. We know that this contour is retained throughout life in the Guinea fowl, the turkey, the partridge, and the quail. We also see it in the earlier stages of the chick of the domestic fowl, that is to say before the feathers of the tail begin to grow in an upward direction. It is noteworthy that the compressed narrow shape of the body of the corn-crake (and of *crakes* in general), offers but little resistance to the air during the bird’s rapid flight. It is startling to witness a corn-crake cutting through the air at one hundred miles an hour, and I feel convinced that the Carolina crake is no less swift and buoyant on the wing. The narrow body also permits a crake to wend its way rapidly on foot through dense and tangled vegetation. The corn-crake measures about ten and a half inches from the tip of its beak to the tip of its tail: the Carolina crake is about two inches shorter.” (Fig. 82, A.)

THE TWO CRAKES DIFFER IN DRESS.

“The dress of the two birds differs markedly; yet in some directions it calls for interesting comparisons. The striking feature in the Carolina crake’s costume is its extensive coal-black throat-gorget, which intersects in the middle line the grey ground-colour of the breast; a narrow black girdle encircles the base of the yellowish-white polished beak.

The contrast in colour here gives a pleasing effect. The general shade of the upper plumage is olive-brown with a tinge of very dark dull red, the feathers being barred with black and finely pencilled with white. The cheeks, eye-stripe, sides of neck and breast, slate-grey; the rest of the under parts, dull-white; the feathers lining the under surface of the tail, suffused with warm rufous." (Fig. 82, B.)

FAIR AND DARK COMPLEXIONS.

"The clear, bold, dark and light bars, which traverse the flanks, are very noticeable. Here a comparison may be drawn with the same in the corn-crake, but which are in shade, chestnut and buff. In the latter species the upper plumage is brownish; but the feathers are so broadly edged with buff, the wings are such a decided chestnut-colour, and chestnut and buff stand out so markedly on the flanks, that we may say the dress in general bears a rufous shade. The greyish-white throat, cheeks, and under parts, do not take away from the ruddy character of the costume."

"The corn-crake is, as it were, an individual with a fair or *ruddy complexion*; the Carolina crake is an individual with a *dark complexion*!" (Fig. 82, A. B.)

"Make free use of the Public Museum in comparing and otherwise studying plumages."

* * * * *

FAREWELL, AND GOOD LUCK, MR. HUNTER.

"Mr. Hunter, before we part company, I have to whisper in your ear a strange secret!"

"Are you aware that all the time we have been conversing on birds we have been overheard by hundreds of boys and girls in various schools?"

"Sir," said the old man, half in a suspicious tone, as though he had some notion that I 'was pulling his leg,' "you cause me great surprise—what do you mean?"

"Mr. Hunter, have you not heard of the wonders of '*Wireless*' Talks?"

"No, sir."

"Ah! you are indeed far behind the times. Find out all about '*Wireless*,' Mr. Hunter, without delay; believe me, you will not regret it. I have no time at the present moment to explain it. I really must be off, so let me wish you very warmly, Good-day and Good-luck."

* * * * *

So now, my dear young friends, Mr. Hunter—the old Skipper—has departed. As I hurried away along the beach I looked back once or twice, and saw him slowly wending his way towards the cheery cobbler's hut.

He will certainly have a good yarn to spin to Mr. Leatherstitch to-night. He was not a bad old fellow after all, and took quite a lively interest in birds.

I think he learned a lesson, and will in future exercise self-restraint, and not lose his head again through mad excitement, if he drops across another strange bird.

I am glad that I took him into my confidence, and I am sure that it was the right thing to forgive him.

He will remember our long and interesting chat for many a day to come, and no doubt benefit by all he has learned about the problems of *Trans-Atlantic Bird-Migration*.

WE ALL ASSEMBLE ON THE BEACH.

"Let's pretend" that you all also met him on the beach; saw the poor little miserable American goldfinch; accompanied him and me to the house of Mr. Leatherstitch where

you were shewn dozens of little birds in little cages ; strolled back along the beach ; and finally listened attentively to our long conversation on the subject of *Casual Visitors from the New World*.

I do hope most sincerely that you understood all we said, profited by what you heard, and enjoyed yourselves.

If ever you have an opportunity of visiting Dublin, do not forget to call at the National Museum and see the
FEATHERED TREASURES FROM THE IRISH LIGHT-STATIONS.

FINALE.

CHAPTER XXXII.

OUR STORY IN A NUTSHELL.

THE GRAND AND FINAL "LET'S PRETEND."

SO I hear that you enjoyed your summer holidays immensely, my young friends.

I am truly delighted that you all had such a good time.

The weather was not by any means ideal.

For the last time "let's pretend" something!

What would you suggest?

I have thought of something very pleasing: certainly to me, and I trust to you all.

Here goes!

"Let's pretend" that you have read through the manuscript of our book,—*The Story of the Birds*. Pray now accept my very best thanks for letting me have such copious notes from which to frame the *summary*; they have been very carefully put together, and though I have edited them, the work of the summary must be regarded as your own contribution.

It was really splendid that you made such good use of your time on the many drenching days when you were compelled to remain indoors.

I send my hearty congratulations, and am very glad that you are unanimous in your opinion in regard to the most interesting points to recall.

I share the same view.

The entire manuscript will be sent off to the Publishers to-morrow; your excellent summary, of course, included. We all wish very much to know what a book is about before venturing to peruse the pages from the beginning.

The summary, although it forms the last chapter, foretells the story in a nutshell.

THE STORY IN A NUTSHELL.

The marvellous vision with which birds are endowed, immediately riveted our attention. We recall the pleasant chat we had in *the room with a thousand windows*; why even the most remote bird saw the cat and quaked! Thirty-two goldcrests by post for the sum of one penny: feather-weight fairies, forsooth! What prodigious appetites birds possess! We could not possibly live owing to insect-pests, but for our friends the birds. It was quite an entertaining business hunting for the ears and nose. Our discussion on the sense of smell was most instructive: so were the weird experiments performed on behalf of the captive vulture. We found grinding or 'back-teeth' not in the mouth but in the stomach—in that subdivision named the gizzard. But then, we have not forgotten the swallowed pebbles and grit. At first we seemed almost frightened when the great solemn owl screwed his head nearly right round his neck; of course nothing tragic happened, the head did not come off the body! Indeed far from it, we soon learned that a bird needs have a very flexible neck to compensate for its markedly rigid body. The latter is shaped like a boat with a well-developed keel. The

breast-muscles and heavy organs provide remarkably efficient ballast. The former are developed to an enormous extent, thereby enabling the wings to be hauled down through increasingly resisting air. We denuded a bird's wing of its feathers. We saw that the framework closely resembled that of the human arm. We treated the hind-limb similarly. We observed the correspondence of the framework with that of the human hind-limb. We have carefully borne in mind that the fingers of the bird are joined to a very considerable extent. The toes, on the contrary, are very free in the great majority of birds, nay more; the foot can grasp and function as a hand. The plumage means much to its wearer. Chick Pheasant told us that so very sweetly. He spoke pleasingly, not like grumpy, cross-patch, Mr. Caterpillar. Baby Bunny recounted his simple story in timid accents, but he was most polite and agreeable. Some birds are endowed with a very varied and liberal wardrobe. Our thoughts turn to the herring-gull, who comes out dressed in a different kind of fashion for five successive years! Next we contemplate upon the never-ending variety of wedding-garbs: frills, tippets, crests, combs, wattles, and other 'fancy-dress' fineries. Among these we soon discovered several strikingly handsome liveries. The mechanics of the limb-muscles proved a most absorbing study. Here we definitely formed the opinion that a dead bird must be preserved, and when the muscles have been carefully dissected out, their actions must be repeatedly put to the test by pulling the various tendons. It was highly entertaining and also instructive, working out the main factors which determine the mechanism of perching while the bird sleeps. We saw that the correct balance was easily secured. This, associated with overhead weight and free bending of the zig-zag props formed by the hind-limbs, constituted, in the main, the passive machinery. The vital

organs we found boxed up snugly and securely. They are protected by strong buttresses of bone from the great shock which the powerful down-stroke of the wings would otherwise produce. The dispersal of the major parts of the lungs over the body, in the form of multiple air-sacks, doubtless must prove a wonderful adaptation to the flying-bird. The vocal machine is really quite unique. The volume of sound—purely musical in many instances—which pours out through tiny tubes, is truly astonishing. The language of birds; the call-notes, alarm-notes, battle-cries, and song, are so varied, not only in different species, but individually, that very close and patient study afield is necessary. Moreover we must put our studies in this direction to repeated practise. We were certainly surprised to learn that song is so much bound up with pugnacity. It would be difficult to forget the robins' fierce yet tuneful duel, and also Mrs. Robin as she looked on all the while, and enjoyed the boxing. The battle being over, she seemed to listen with rapt attention to the music of the rivals' songs. The scene of this robin incident must be still very fresh in our minds. What an entrancing time we had in the wood; how the ripples of the brooklet grew ever more and more melodious; how mystically musical became the shimmering leaves: surely the blackcap and the wood-warbler afforded us a rare treat. Then the fugal chorus of the willow-warblers proved most arresting, even though we heard them so repeatedly. Ah, yes; it was a glorious day; all too short! Certainly we must listen to the singing of the birds again and again. It is only by plenty of practice that our ears grow familiar with the wonderfully varied and extensive bird-vocabulary. The mechanism of flight, no doubt, is a complex theme, but full of interesting surprises. It was fascinating to learn that, owing to the balance of the body being so capable

of rapid and perfect adjustment, the bird when flying cannot be capsized. Quickly indeed the tumbler pigeon is obliged to right himself, after having indulged in a somersault ! We remember that, in order to raise the body, the wings work on the lever-system. The fulcrum, here called into play, is curiously interesting, a moveable one to wit, and naught else than the air itself, subjected to pressure. We recollect the ready manner in which birds can sail alongside a cliff or a moving steamer, where induced ascending-currents of the atmosphere offer support. It was a delightful and at the same time a most exhilarating day which we spent with our feathered friends on beach, marsh, and hill-side. Our ramble was for the set purpose of studying wing-movements. In the problem of flight, we associated, on the one hand, weight, power, velocity, and small wing-surfaces ; on the other hand, buoyancy, feebleness, slowness, and ample wing-surfaces. In either case, birds are heavier than air, and are such absolute masters of flight, that Ruskin was inspired to symbolise them as the *air itself*, "conscious of itself, conquering itself, ruling itself." Our studies of the anatomy of the wings, and the amazing manner in which the muscles work, permitted us to understand how it is that birds can accomplish very protracted journeys on end, without undue fatigue. The migration of birds no doubt forms a very comprehensive theme. Problems of exceptional interest are gradually being solved ; though some are still beyond our ken, and await solution. The subject took us far afield, despite our endeavours to curtail it, hence several of the later chapters in our book have been devoted to this branch of ornithology. Endurance on the wing is a primary factor, far more important than velocity. Birds have immense appetites, and the food-question becomes a potent factor in regard to migration. Migratory birds

breeding in the Northern Hemisphere move southwards for feeding-purposes, at the approach of our cold season. The short hours of day-light also drive arctic birds southwards in winter. We learned that the return journey north, from southern quarters, is not primarily in search of food, which could be obtained in plenty without migrating. The journey is made for breeding-purposes. Instinct drives the migrants home with feverish haste. The overwhelming desire to reach the old home is firmly ingrained. Our so-called summer-visitors are strictly speaking summer-residents: they are natives of the soil because they return to their breeding-homes. The swallow, cuckoo, corn-crake, and several species of the warblers, are familiar examples. We extended a most cordial welcome to our summer-birds. Among them are the sweetest minstrels of the feathered world. In form they are beautiful; in habits most interesting. Our winter land-birds largely comprise species which also breed in our Isles. Their arrival for the most part is uneventful: their form, flight, and plumage, are not much out of the common: their song is hushed to sleep. Hard weather may afford us the means of identifying some very interesting purely winter-birds, that is to say those which do not breed in our Isles. The bramble-finch and redwing sometimes visit our suburban gardens. Marine bird-life in winter offered an entrancing study. A ramble on the sand-flats and ooze-beds revealed legions of delightful birds, consisting of many and varied species. We learned that there is a wide variation in the Geographical Distribution of migratory birds, not only in different species but among individuals of the same species. Extensive migrations are often made by some water-birds. Young birds, when only three months old, embark upon immense journeys, independent of the guidance of their parents. Some Turnstones fly from Arctic Europe

to Australia! The Curlew-Sandpiper, starting from Arctic Europe, reaches in some instances New Zealand! Migratory birds are classified mainly into summer-residents, winter-visitors, and birds-of-passage. The movements of the birds-of-passage throw light on the purport of migration in general, apart from the question of movements to and from the British Isles. The periodic fly-lines of birds native to the Southern Hemisphere are reversed. At the approach of winter the journey is made from south to north for feeding-purposes: at the approach of summer, from north to south for breeding-purposes. Outward-bound migrants from both Hemispheres, converge; homeward-bound migrants, diverge. We recollect the remarkable travels of shearwaters, from their breeding-quarters afar off in the Southern Hemisphere, to within the Arctic Zone. Some movements are very irregular. The sudden and great 'invasions' of Pallas's Sand-Grouse from their home in the Asiatic Desert are undoubtedly astonishing phenomena. The erratic westward drifts of Waxwings from their Arctic home, and the wide-spread 'irruptions' of Crossbills to our Isles and elsewhere, are all matters of intense interest to the student of bird-migration. What a thrilling observatory a light-house is on a migration-night! From light-stations rare specimens have been picked up, including the largest percentages of casual, otherwise accidental visitors. From Irish light-stations we recorded very valuable specimens, most of which were in excellent condition and shewed evidence of having made the journeys post-haste, piloted by other species, closely related. But we cannot forget the exceptional case of the Icterine Warbler; a storm-driven poor wee waif, in a sadly emaciated condition. We eagerly followed the Geographical Distribution of these *rare aves*; we examined their bodily conditions, and at the time of their capture we recorded the presence of

other migrants. Such data afforded us a clue towards an attempt to unravel the purport of these rare travellers' visits. Difficult no doubt, but extremely interesting were the problems we discussed in regard to the migrations which American birds accomplished in order to reach our shores. The aged skipper—Mr. Hunter—spun a very strange yarn concerning the flight of an American Goldfinch across the open Atlantic Ocean. This same gentleman shewed us the bird: it was in miserable condition, both in body and dress. We greatly doubted whether it could fly the length of a small garden! The story, when analysed, could not hold water. The skipper knew that he was being detected: he withdrew his statement and repented. We forgave him, and found him companionable and deeply interested in birds. We had a lovely and most instructive discussion regarding assisted passages: we agreed on sound evidence that birds do not always depend upon ships to take them across the Atlantic Ocean. The types of birds most capable of accomplishing the Trans-Atlantic trip are chiefly sandpipers. We have a vivid recollection of the exciting scene far out on the ocean, where a party of sandpipers had a 'Robinson Crusoe' kind of experience on a 'raft!' We certainly marvelled when we learned of the vast wanderings at times of the Corn-Crake and the great speed at which it could fly. In the New World the abundant Carolina Crake is equally swift and strong on the wing. Wonderful to relate a Carolina Crake, flying at full speed, struck the lantern of an Irish lighthouse. This had been the first Irish specimen recorded. It was in splendid condition, no doubt a vigorous migrant, which crossed the Atlantic Ocean at an extremely rapid speed, without an assisted passage. The old skipper was deeply interested and expressed delight when the plumages of both crakes

were described and then compared. He was also particularly interested to hear about 'Wireless' wonders. Advice was given him to keep abreast of the times, and without delay to try and understand what is meant by broadcasting. Wishing him Good-day and Good-luck, we parted company.

Greetings.

Dear Young Friends,

My task is now completed, if indeed it may be called a task. Personally, the writing of this book has been a most delightful undertaking ; in truth, a real labour of love.

In endeavouring to frame a useful volume from the addresses which you have heard, my aim, all along the line, has been to enrich and weave the contents, rather than to transcribe. For that reason, many of my original remarks, homely and unconventional in character, projected over the wireless, are in a large measure reproduced *verbatim* in the text.

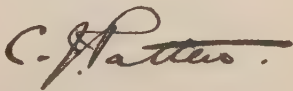
In the preparation of the work, it is *you* who have been always uppermost in my mind.

The question ever before me has been : can I manage to make the theme upon which I have written, sufficiently interesting and instructive to justify its publication ?

Fully aware of my shortcomings, I have nevertheless made the plunge rather than stand shivering on the brink.

If the perusal of these pages afford you some degree of pleasure : if you should profit by what you read ; and if you should be stimulated to study with zeal and patience *The Story of the Birds* from the *Book of Nature Herself*, then I feel that my efforts have been more than amply rewarded.

With Greetings,

A handwritten signature in dark ink, reading "C. J. Patterson." The signature is written in a cursive style with a long horizontal flourish extending to the right.

University,
Sheffield.



BLACKCAP.



The Index.



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THROUGHOUT A UNIFORM SETTING; OTHERWISE ALL WORDS DENOTING
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